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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Telephone: Central 1585. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332.*)

Forthcoming Events.

MAY 22-24.

Institution of Mining and Metallurgy:—Special meeting in Cornwall.

MAY 26.

North of England Institute of Mining and Mechanical Engineers:—Ordinary meeting at Newcastle-on-Tyne. "The Use of Carbon Monoxide Masks in Mines," Paper by Richard White.

JUNE 9.

Institute of British Foundrymen.

West Riding of Yorkshire Branch:—Summer outing.

The Advance of Refined Irons.

We find it interesting, and most foundrymen will share our interest, to watch the development of synthetically-produced pig-iron, now generally known as refined pig-iron. Barely a decade ago the output was comparatively small, and the product was regarded by most foundrymen with a certain amount of suspicion. The reason for this attitude may have been indifference, ignorance of its properties, or prejudice, but we prefer to think that the average standard of refined iron has been improved. It is certain that a reliable article cannot be produced by haphazard or rule-of-thumb methods, and that to-day the better grades are made by scientific control with up-to-date plant and equipment. The insistent demand for high-grade castings under conditions of fierce competition has practically forced the general use of such iron, whether purchased from firms specialising in its manufacture or produced in the foundry under the control of the technical staff.

In its broadest sense, the term "refined pig-iron" may refer to any iron which has been subjected to an after-treatment to render it more suitable for a particular operation. Actually the term is used to cover a variety of pig-irons of exceptional physical properties and chemical compositions, produced by blending various blast-furnace pig-irons and diluting the constituents present with steel in some form or other. The methods of bringing about this dilution are many and various, but in all cases exceptional precautions are taken in the manipulation, and a very high degree of control is necessary at all stages in the process to ensure the uniformity and regularity of the product. The extent of this control is really a matter of considerable astonishment to many foundrymen who behold it for the first time, and the effect of this control is that it enables a pig-iron to be placed in the hands of foundrymen having a tensile strength of from 18 to 20 tons per sq. in. This is surely a complete vindication of the high position to which refined irons have attained.

This position reflects the progress which has been made in ironfounding during the past few years. It is within the memory of even our young foundrymen that such high tensile strengths were a matter of extreme rarity in castings, and eagerly sought after. Now they are available and can be purchased ready made in the pig-iron. The better understanding of the composition, condition and treatment of cast iron from the point of view of their influence on the character of the final product has in itself created the demand for supplies of iron having well-defined properties and characteristics which can be maintained with certain regularity. This demand has now increased beyond the limits of that which could be met by selection from the normal blast-furnace products, and is more than amply met by the refined pig-irons; the product of modern refining processes.

There can be no doubt that modern refining processes by their very nature lend themselves to still further improvements in the character and quality of the pig-irons available for special purposes. The improvements in engineering designs which are constantly taking place are always demanding improved qualities and characteristics in the castings, and we confidently predict that modern refining processes will play a still further important part in the production of iron for modern high-duty castings.

Invention and Discovery.

Although it is fairly obvious to us that England could reasonably claim to have led the world in the matter of scientific research over the last decade or two, it is pleasing from time to time to be assured that well-informed foreigners would concede the justice of the claim. We are, of course, fortunate in the possession of men of the type illustrated by Rutherford and Bragg, whose work alone would ensure a very high average, but they are by no means unsupported.

But if we are in the van in this matter of scientific research why are we not also the undisputed industrial leaders of the world, since we are told on all hands that science is the key to progress to-day? For a very simple reason—we make our discoveries, but we do not apply them. The result is twofold. In the first place our own practical development lags behind our theoretical advances, and in the second place others with a clearer perception of the position step in where we have feared to tread and reap a double advantage from our sowing—being the first to apply our work and subsequently being able to levy a toll upon us when we desire a share in the benefits.

The fact is that discovery alone is not enough; indeed, it is of no direct or immediate use to industry, which requires its practical application by means of invention. Inventions—we are not in the present instance referring so much to the conception and design of novel "gadgets" of a mechanical nature as to the application of new scientific knowledge to industrial practice—are patentable; discoveries are not. Hence it arises that we who make the discoveries give them freely to the world, while other people elaborate the inventions arising out of them and reap the benefit in patent royalties.

It is not enough for our scientists to make discoveries, no matter how valuable, how revolutionary; it is not enough for our manufacturers to look kindly upon scientific research and express their willingness to support it. It is not the scientist's business to put his work into useable shape—his very qualifications as a scientific worker disqualify him for this further function, which demands not merely an intimate knowledge of the working of a given industry but also that regular and habitual contact with it which alone can show where improvement is required. In a similar way the manufacturer's very ability *qua* manufacturer disqualifies him from detailed scientific research, so that he is no better situated.

We have previously pointed out the need for a liaison officer between these two sharply differentiated classes of people, but more is wanted. We need wholesale encouragement of applied research

through research associations, through scientific staffs, and other similar means.

Naturally the application of all discoveries will not fall to the lot of any one manufacturer, and to the individual there may well appear to be much chaff and very little wheat. But the wheat when it does come yields great rewards—rewards that are missed by those who allow themselves to be permanently prejudiced by a preliminary handful of chaff. J. G. P.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Lanz Perlit *versus* Thyssen-Emmel Litigation

To the Editor of The Foundry Trade Journal.

Sir,—You will, I am sure, be interested to hear that the litigation which has been going on for the last three years between Messrs. Henrich Lanz A.G., of Mannheim, and Mr. Karl Emmel, of Mulheim-Ruhr, backed by many firms of high repute in Germany, has now been terminated. A settlement has been arrived at by all the opposing firms agreeing to recognise the novelty, validity and economic value of the Lanz Patent processes.

I am given to understand that all the opposing firms have taken up Lanz Perlit manufacturing licences. Amongst the new licensees are great works such as Vereinigte Stahlwerke, Gelsenkirchen, Maschinenfabrik A.G. Nuremberg (M.A.N.), Gutehoffnungshutte, Esslingen, Borsig, and many others. We are also informed that the Government authorities and the Standards Associations in Germany have created a new high-quality standard of cast iron which can only be obtained economically by using the Lanz processes.—Yours, etc.,

The British Perlit Iron Company, Limited.
John A. Smeeton, Managing Director.

[This letter has been somewhat abridged.—Editor.]

Obituary.

The death has occurred of Mr. A. J. Tople, of Derby, who was one of the best known men in the local foundry trade. The deceased was formerly chief draughtsman at Haslam's Foundry & Engineering Company. He was a prominent Freemason, being a Past Master of the Arboretum Lodge.

The death has occurred at Derby of Mr. Lionel Dodds Reay, a member of the staff of the Derby Technical College. The deceased, who was well known in the iron and steel trade, became an engineering and workshop instructor at the College in 1904, after serving several years with various firms in the district. From 1889 to 1893 he was employed by Messrs. Russell & Sons, Peel Foundry, and later at Simpson's Lever Chain Works, Draycott, and at Messrs. Cutting Brothers, electrical engineers. From 1897 until taking up his position at the Technical College he was employed in the electrical department of the Midland Railway.

Book Review.

The Rapid Per Ton Reckoner.—Published by Messrs. Gall & Inglis, 31, Henrietta Street, London, W.C.2. Price 1s. 6d.—A book of this character can be very useful in and about a foundry, but there is just one use to which we hope it will not be put, and that is in connection with the sale of castings at so much per ton instead of a price per casting. For stocktaking and the like it will be found to be very useful.

Mr. Stubbs' Illness.

On inquiry on Tuesday last we learnt that Mr. Oliver Stubbs is still in a serious condition. He had a relapse about ten days ago, since when his condition has been unchanged.

Catalogues Received.

Foundry and Metallurgical Plant.—The points of contacts which Messrs. Gossell & Son, Limited, of 110, Cannon Street, London, have had with the foundry and metallurgical industries have recently been increased by an establishment of agencies for the sale of grinding, bunkering, conveying machinery, and the installation of pulverised fuel furnaces. The range now dealt with has nothing experimental about it, as they are the products of Messrs. Berg & Company, of Bergisch-Gladbach, near Cologne, who have carried out some 400 installations, including 40 steelworks and rolling mills. Messrs. Gossell have sent us four pamphlets, the most interesting of which deals with the pulverised coal firing of industrial furnaces. In this illustrations of many interesting examples are given, ranging from the reheating of non-ferrous billets to chilled roll metal melting. For oxidation losses the paragraph on page 3 is rather vague, and reference should be made to page 3 of "Extracts from Testimonials," which shows it to relate to an ingot reheating furnace wherein the waste was reduced from 4.5 per cent. to 1 per cent. A second pamphlet confines its attention to the application of pulverised fuel to steam boilers, whilst a third is devoted to the grinding of the fuel. These are economical in the space taken up and can either form a central unit or be directly connected to the furnace. That pulverised fuel is of considerable utilitarian interest to the foundry industry is indisputable, and our readers would be wise to study carefully any recent development such as is disclosed by the pamphlets under review.

Hardness Testing.—Messrs. Edward G. Herbert, Limited, of Atlas Works, Levenshulme, Manchester, have prepared a four-page leaflet dealing with the Pendulum Hardness Tester. This instrument ought to be better known and more widely applied to the testing of cast-iron, as precision results are given of the skin hardening produced by wear and abrasion, such as is produced on the surface of cylinders and pistons after service. Moreover, mass inspection testing can be expeditiously performed. Finally, a factor which we personally appreciate from experience is that the mass, hardness or thickness of the specimen, is said not to affect the test result.

Publication Received.

Proceedings of the Institution of Production Engineers, Vol. VI, No. 3. Price 1s., from Mr. E. D. Ball, 20, Lushington Road, Harlesden, London, N.W.10.—This issue contains an address by Mr. Hazelton on The Registration of Engineers. This question is of vital importance to foundrymen, as unquestionably sometime in either the near or distant future engineering will become a closed corporation, such as is enjoyed by the legal, medical and dental professions. It will be followed by an application from the metallurgists and the founder, being the parent of both, will be proud of the status enjoyed by his offspring, whilst still bearing the appellation of "tradesman" and not "professional." We strongly urge all founders to procure a copy of this particularly useful publication, and become "noisy" during the infancy and adolescence of this movement.

Staveley Coal and Iron Company, Limited, near Chesterfield have changed their telegraphic address from "Staviron Barrow Hill" to "Staviron, Hollingwood."

Mr. Ernest Wells, a director of and foundry manager to Edgar Allen & Son, Imperial Steel Works, Sheffield, has returned to England after a short business trip in South Africa.

The Mineral and Refractory Products, Limited, of Abbey House, Victoria Street, London, S.W.1, have been appointed agents for Messrs. Robson Refractories, Limited, of Darlington, whose name is so closely identified so far as the foundry industry is concerned with Cupoline.

The Leicester Conference.

Subscription List Opened:

The progress which the Reception Committee of the Newcastle Branch of the Institute of British Foundrymen have made can be judged by the first list of subscriptions received. Already of the £500 asked for well over £300 has been found. Mr. S. H. Russell, the chairman, Mr. Bunting, the honorary secretary, and Mr. H. H. Moore, the honorary treasurer (of "Holmwood," Leicester Road, Loughborough, and to whom additional subscriptions should be sent), are to be congratulated on their initial success. The list of subscriptions now is:—

	£	s.	d.
S. Russell & Sons (Leicester)	31	10	0
Herbert Morris, Ltd. (Loughborough)...	26	5	0
Combustion Engineering Co., Ltd. (Derby)	26	5	0
Ley's Malleable Castings Co. (Derby) ...	25	0	0
The Stanton Ironworks Co., Ltd. (Near Nottingham)	25	0	0
Derwent Foundry Co. (Derby)	20	0	0
W. Hammond & Co. (Syston)	10	10	0
B. and H. Brahams (Bury St. Edmunds)	10	10	0
S. A. Gimson (Leicester)	10	0	0
G. Potter & Sons (Leicester)	10	0	0
Wadkin & Co., Ltd. (Leicester) ...	10	0	0
T. Spiers (Leicester)	10	0	0
H. H. Moore (Loughborough)	10	0	0
The Staveley Coal & Iron Co. (Sheffield)	10	0	0
Messenger & Co. (Loughborough) ...	5	5	0
Fordath Engineering Co. (West Bromwich)	5	5	0
J. W. Jackman & Co. (Manchester) ...	5	5	0
Baker Perkins, Ltd. (Peterborough) ...	5	5	0
General Refractories, Ltd. (Sheffield)...	5	5	0
Foundry Trade Journal	5	5	0
British United Shoe Machinery, Ltd. (Leicester)	5	5	0
James Durrans & Sons, Ltd. (Penistone)	5	5	0
The Constructional Engineering Co., Ltd. (Birmingham)	5	5	0
J. T. Goodwin (Sheepbridge)	5	0	0
Goodwin, Barsby & Co. (Leicester) ...	5	0	0
G. Perry & Sons, (Leicester)	5	0	0
Edwin Cook, Ltd. (Loughborough) ...	5	0	0
Wright's Havelock Foundry Co. (Leicester)	5	0	0
T. W. Ward, Ltd. (Sheffield)	3	3	0
Foundry Plant & Machinery, Ltd. (Glasgow)	3	3	0
Iron Founders' Association (Leicester)	2	2	0
W. Richards & Son (Leicester)	2	2	0
Penton Publishing Co. (London) ...	2	2	0
A. T. Green & Sons (Rotherham) ...	2	2	0
F. Pollard (Leicester)	2	2	0
Isaac and Israel Walker (Rotherham)	2	2	0
Electric Furnace Co., Ltd., (London)	2	2	0
Wigan Coal & Iron Co., Ltd. (Wigan)	2	2	0
John Lucas (Loughborough)	2	0	0
T. Goodwin (Lutterworth)	2	0	0
C. W. Coleman (London)	2	0	0
Cheetham & Hill, Ltd. (Derby)	1	1	0
S. Hadfield (Leicester)	1	1	0
A. S. Clarke (Loughborough)	1	1	0
Joseph Boam, Ltd. (Leicester)	1	1	0
Parson & Crosland, Ltd. (Birmingham)	1	1	0
W. Wyborn (Notts)	1	1	0
J. J. Jones (Loughborough)	1	1	0
Courts & Co. (Radford Station, Notts)	1	1	0
Hall & Pickles, (Leicester)	1	1	0
George Grant (Loughborough)	0	10	0

Further lists will be published later.

Slight damage was caused by a fire which occurred at the foundry and wagon works of Messrs. Rigley's, Bulwell, Nottingham, on May 8. Production, however, has not been interfered with.

The annual meeting of the Association of Special Libraries and Information Bureaux, whose head offices are at 26, Bedford Square, London, W.C.1, will be held at the New College, Oxford, from September 14 to 17, 1928, under the chairmanship of Mr. J. G. Pearce, the Director of the British Cast Iron Research Association.

Foundry Moulding Boxes.

At the meeting of the Lancashire Branch of the I.B.F., held on April 14 at the Manchester College of Technology, Mr. E. Longden in the chair, a Paper entitled "A Foundry Problem" was read by MR. J. HOGG, of Burnley. He said he had often been impressed with the large amount of capital which was laid out and locked up in moulding boxes. In many foundries they seemed to occupy every available inch of room, both under cover and out in the foundry yard. He did not propose to deal with the large-sized ones, but would confine his remarks to those of medium or small size, of which there were a vast number. The first cost was fairly heavy, the cost of maintenance was a burden, and the continual necessity to overhaul them, particularly when wanted for quick and accurate production, was very troublesome. The foundry problem he wished to deal with was: How could the expense of those moulding boxes be reduced and at the same time the production be maintained or increased? Some little time ago Mr. West answered that question by suggesting moulding in cores. But that needed dry-sand moulding, and he himself had in mind green-sand moulding. So he called attention to the merits of snap flasks. In a number of foundries snap flasks were much used and were successful, but he was aware that some objections to them could be raised and he would be glad if they were put forward on this occasion. Whatever they were, a meeting of this kind was the audience most capable of judging them. His own view was that snap flasks could be utilised more. In that way capital outlay would be smaller, the moulder would have less lifting to do, and production might be increased. If the members knew anything which would help towards these objects they ought to tell one another about it.

Garden Seat Legs.

There were three jobs he would describe, and his audience would be helped to follow him by lantern slides thrown on the screen. The first one was a casting of form legs, of rustic pattern, weighing ¾ cwt. each. An order came in for 200 of these at a competitive price, and it was required that they should be of good quality and delivered as quickly as possible. They had been made previously at this foundry by loose pattern moulding, but on this occasion it was decided to adopt a different method. They were jointed in the middle. White metal castings were made in halves, and, being of soft metal, they were easily filed up and mounted on a wooden pattern plate. Six new cast-iron moulding boxes were made measuring 3 ft. 6 in. × 2 ft. 4 in., with 4-in. tops and 5-in. bottoms. They were drilled and pinned to jig. These boxes allowed two castings per box. The seat part and the feet part were blocked off by slabs of core to prevent any twist or joint mark. In the blank spaces flanges, etc., were moulded, as was the custom in the East Lancashire district. The job was given out to a plate moulder, and before noon those boxes were moulded and work was stopped for want of boxes. The boxes were expensive to make, they took up a large amount of space, and the machine shop hinted that they had other work for the machines, apart from preparing moulding boxes for the foundry. Unfortunately the firm lost another order for 100 which was put up by a neighbouring municipal authority.

Potentialities of Snap Flasks.

If that job was put in his way to-day he would endeavour to make it in snap flask. One snap flask, top and bottom, would be required, and bottom boards for each mould—although this was not imperative when moulding on the floor—and a number of loose bars for each mould, drilled at the ends, say five bars per mould. He would arrange for at least twelve moulds per day. The snap would be drilled and the bars pinned in position while the moulding was taking place; they would be released before the flask was withdrawn. They would require flat weights for the tops, made in halves for convenience in lifting. Two sets would be enough. No binder would be needed for this job, as the feet of the casting, which were nearest the outside, were blocked.

Plaster Moulding.

The second matter he wanted to put before the members was a method of using snap flasks for plaster moulding. Suppose an urgent job came in for 50 small brackets, and they had two patterns. They could be any size. For instance, suppose they were 12 in. long and 6 in. wide at the foot end. They would take up some little time loose pattern, and if the job was for 50 they would be worth mounting on plaster. It might be a repeat job. A box of 18 in. × 12 in. was a popular size of snap flask, and for this purpose two would be needed. However, they were extremely handy, useful and cheap. They would require to drill and tap the customer's pattern if it were metal, which it most likely would be; if it was wood ordinary wood screws should be satisfactory. They would be to hold the patterns firmly in the plaster. One snap would be used to hold the plaster parts, and one snap to mould with, ramming the tops from the bottoms and the bottoms from the tops. After the moulds were made they could unscrew the customer's patterns from the plaster, send them away with the castings, release the plaster blocks from the snap, and put them away on a shelf, to be taken down again and re-inserted in the snap if another order came along.

Another job was moulding hollow rims, double flanged pulleys, etc., in snaps by means of binders or loose rings. This was a very quick and accurate way of making wheels, pulleys, etc., and did away with any need for three-parted boxes.

DISCUSSION.

MR. R. A. MILES said the best way of dealing with moulding boxes was quite a problem. If a foundryman broke up his heavy boxes, he might find that one of them was wanted soon afterwards; on the other hand, if he saved them, several years might pass without his having a job to put in them.

With regard to small moulding boxes, snap boxes had a place; so also had fixed-pin boxes of cast iron, wrought iron or steel. Much depended upon the particular type of job, plate, or machine that was going to be used in conjunction.

Very light castings could be made admirably in snap flasks, but with the heavier kind of castings there would be the trouble of preventing a breakout. This is obviated by putting steel or wrought-iron rings inside the mould and adding to the cost, and eventually the job would become more expensive than if a fixed box had been used.

Moulding boxes should be made interchangeable, but quite a number of foundries, even in these enlightened days, had no real experience of what an interchangeable box should be. Generally, the best type of interchangeable moulding box was given to the semi-skilled or unskilled man, being made foolproof so as to enable the production of good castings expeditiously.

Snap flasks could be used, not only as an ordinary pair, that is, top and bottom, but also for three and four part jobs, providing the job was of such a nature that it would not burst the side of the mould when the metal was poured, after the box had been removed. Snap flasks certainly have their place in the foundry and considerably more use might be made of them in certain light types of castings.

He was afraid that, referring to the Scotch system of moulding, taking the stove-grate trade as the example, snap flasks in any quantity would never be considered. Foundrymen trained in Scotland usually make their boxes for light repetition work, with a V-pin at the end of the box-part. These pins were adjustable; there was no machining on the boxes, just a facing which could be readily adjusted, and jobs were set out to fit most of the standard boxes, or if necessary, special boxes were made to suit particular shapes of patterns.

Objections Raised to Snap Flasks.

MR. A. SUTCLIFFE said he considered that in the first job described—the form leg—Mr. Hogg would have gained a great deal by putting it closer together; the box would have been lightened and made less bulky. He himself would do that job in an iron box; as it would be cheaper, and a more substantial job—a better job in every way—than by doing it with a snap flask. In a jobbing shop—or in any other shop for that matter—the box adopted should be suitable for any purpose.

There was nothing new about the second job, the bracket. He had made hundreds of similar things. The necessity of having the up-joint could be done away with by having a flat bottom and a flat top. Mr. Hogg might make it with the snap flask if he liked, instead of the iron box, but his (Mr. Sutcliffe's) own view was that he did not care much for snap flasks, especially for a job of that character.

He had in his yard boxes 10 ft. long by 6 ft. wide which had been used for years. They would take any reasonable job of its kind. It was a matter for the man who was organising the shop or looking after it, and who had to make it pay. The way to do that was not to fill the yard with boxes made for one thing which could not be used for anything else. His advice was, "Don't fill your yard with boxes that have to be scrapped; make boxes that can be used again."

Built-up Box Parts.

MR. S. G. SMITH said when making a large box for general jobbing work he always preferred a built box. It was stronger and could be made suitable for many different jobs. A size of 3 ft. 6 in. × 2 ft. 4 in. was fairly large for a snap flask.

As a way of saving labour with any snap flask he would suggest that where there was any quantity wanted the use of a simple Pridmore or similar machine would multiply the output many times over in moulding or in ordinary plate moulding. It was astonishing to see what semi-skilled men could put down in a day.

Mr. Hogg had referred to plaster work. He himself had a great deal to do with that sort of thing, and he had in mind an establishment where hundreds of master plaster casts were stored away. The men did not use snap flasks, they used boxes.

He thought there was a great advantage to be gained by the use of plaster in the foundry to a greater extent than was now the practice. But as to snap flasks he believed there existed a feeling that it was not a skilled man's job; and perhaps that was one of the reasons why it was not more generally adopted in the jobbing foundry. He agreed with Mr. Hogg that many things not made now with snap flasks could be so made, and that a considerable amount of floor space could be saved by using them.

Plaster Casts Not Always Popular.

MR. A. JACKSON said in regard to the first job described by Mr. Hogg, it seemed to him a difficulty would be to get the bars fixed firmly and at the same time allow them to be quickly released so that when the box was taken away the division would be made without any trouble. When rammed up they should be firmly held in order to be safe, but also they required to be easily released when the box was released. He would like Mr. Hogg to explain a little more clearly how he proposed that should be done.

With regard to the second point, plaster-cast working, he thought they all agreed that was fairly good practice in some shops. In others it was not. Much depended on the men who were working in the shop and on the foreman who introduced it. He had heard of it being introduced and then, after a time, the plaster casts had been on the wall and the men had been working on loose patterns, not because that was really a better or quicker way, but because the men would not work with the plaster casts. Another consideration was that plaster casts took up a fair amount of space in storage. If they were to be got at readily and quickly the shop must be fairly

well organised. Otherwise there would be much time lost in searching, and many rough plaster casts, which would cause almost as much difficulty as boxes. The pulley mentioned seemed very handy, and he had no doubt it would be good in practice. It followed the general principle where pulleys were made in a two-part box instead of a three-part box. He thought a small ring of that description would make it safer to work and probably would be much quicker than the general practice of making pulleys in a two-part box; the substitute for the mid-part being a wet parting sand joint.

INTRODUCER'S REPLY.

Mr. Hogg, replying to Mr. Miles, said he considered that snap flasks could be used successfully for both light and heavy castings. It was simply a matter of arranging the binders. Those need not be made of steel; cast-iron binders, cast open sand, would do quite well; if they were cast the right depth they enclosed the mould as firmly as a moulding flask, and the cost was very low. No machining or fitting was needed, and if they were not required for constant use they could be remelted. He liked great care to be taken in the settling of all pins or lugs for moulding, and with a snap flask one pair only had to be considered.

Mr. Sutcliffe spoke from the point of view of a jobbing moulder who had a life-long experience, so any criticism he put forward had weight. But they were not all alike. Mr. Sutcliffe himself might be able to do that first job more quickly with the ordinary box, but his (the speaker's) experience had been that it was done better and more expeditiously with the snap flask. Of course, it would not be worth introducing the snap flask if only one or two castings were required.

Mr. Smith had suggested that 3 ft. 6 in. × 2 ft. 4 in. were large dimensions for a snap flask. If a man was using Belgian sand—or sand which some people claimed could be provided in this country equal to Belgian sand—there was no limitation as to what size one might reach with snap flasks. He had seen 2 ft. 8 in. used regularly with Belgian sand without binders, and it could not be knocked out. He understood Mr. Smith to say that at the works mentioned the plaster was in boxes, which were put away.

Mr. Smith: No, it is only the plaster cast that is put by. It is the master block.

Mr. Hogg: One has to provide a moulding box with pins in. When that is put by, how is it proposed to remove the plaster block from the moulding box, so as to use the moulding box again?

Mr. Smith: That particular moulding box is not used for plaster cast. Only three or four pairs of boxes are needed, and many castings from these in one day can be made. The boxes receive the metal from the cupola; they are knocked out and are ready for reusing. Obviously there will be a difficulty in jobbing shops, but there is no such thing as being "box-fast."

Mr. Hogg, continuing, said Mr. Jackson asked how quickly the bars could be released. He did not think it would exceed a minute or two. Other methods of fastening the bars while moulding had been suggested, quite quick and good. The foreman would no doubt determine the method to be employed.

A vote of thanks to Mr. Hogg was proposed by Mr. Pell. In seconding it Mr. Masters said he believed a good deal could be said for the snap flask in a jobbing foundry and in repetition work. A type of casting which had been used extensively in housing schemes during the last four or five years was being delivered in this country at the present time by foreign firms at £10 per ton. They were made in snap flasks. He had seen some of those castings. In appearance they were equal to anything produced in this country; he could not speak as to their durability. Similar castings were produced in the Black Country, where it was supposed castings could be made as cheaply as anywhere else in this country, and they could not be put on the market at less than £12 per ton. That was a point which ought to be studied. If the snap flask was good enough for the German or the Belgian it ought to be good enough for the Briton.

The vote of thanks was passed unanimously.

Pulverised Fuel.

In the course of a Paper on "Pulverised Fuel Systems," read recently before the Graduates' Section of the Institution of Mechanical Engineers, Mr. H. Heywood dealt, from within his own experience, with the application of pulverised coal to other than water-tube boilers. His conclusions are summarised below.

The Lancashire boiler had valuable qualities as regards steam-reserve capacity and simplicity, and powdered-fuel firing had greatly increased its efficiency. The grate was removed, and a short extension built on to the front of the furnace, so that a short-flame turbulent burner could fire down each flue. The bulk of the ash was deposited in the flues as a fine dust, being cleared out about every six weeks when working continuously, and a small quantity of molten slag ran out of the furnace extension.

A great field for pulverised fuel lay in its application to metallurgical furnaces, these being at present notoriously wasteful. In malleable-iron heating furnaces, arranged in pairs, each 45 ft. long and capable of melting 20 tons of metal in seven hours from cold, the fuel consumption on the pulverised system was about half the weight of the metal. The furnace temperature was over 1,600 deg. C., and the gases passed into the waste heat boiler at 1,400 deg. C., leaving at 320 deg. C.

In a continuous-heating billet furnace, used for bringing steel billets 3 in. by 3 in. by 4 in. up to about 1,250 deg. C. previous to rolling into sections, the billets were fed into the cold end, and the whole mass pushed up 3 ft. at a time by a feeding mechanism. The coal dust was blown into a combustion chamber, after which the flame passed over the bridge and travelled across the bars. The temperature in the combustion chamber was very high, being over 1,600 deg. C., and most of the coal ash was run out as a slag from the bottom. Half-way along the furnace the temperature had dropped to 1,260 deg. C., while the gases left at 900 deg. C. The gas temperature at the entrance to the stack was 430 deg. C. The fuel consumption was 3.2 cwt. per ton of steel heated, including heating up and keeping in at night.

In a furnace used for heating piles of wrought-iron scrap, previous to rolling, the regenerative chambers had been retained in use since the conversion from hand-firing to pulverised fuel, and these chambers had kept fairly free from ash deposit, only having to be cleaned out every six months. Annealing furnaces for malleable castings had been kept burning continuously for 48 hours at a temperature of 900 deg. C.

Pulverised-fuel firing had also given satisfactory results in other than high-temperature furnaces, such as heat-treating furnaces working at 700 deg. C.; cut-nail heating furnaces at 800 deg. C. gas temperature and 600 deg. C. metal temperature; and core-drying ovens.

Testing Foundry Sands.*

By Senor Joseph Canameras.

The principal purpose of Señor Cañameras's Paper was to emphasise the importance of foundry sands, and consequently the great desirability of forming a close union between foundrymen which would facilitate every kind of research on the subject by means of an effective collaboration between technical men who are specialists or have at least specialised.

An Association of foundry owners and foundry technicians working in close co-operation would prevent the diffusion of effort accompanying individual research, and would save an enormous amount of time. It would, moreover, enable the industry to enter the first rank.

As good comrades and good patriots, they should form an Association to which each one might contribute the fruits of his experience, and in which they might all collaborate disinterestedly, by testing the results, by turning to account their common researches, and by publishing works the importance of which was recognised.

* Extract of Paper presented to the Spanish Foundry Congress. The Author is the Technical Director of the Talleres de Fumisteria y Fundición "Canemaras" Barcelona.

Random Shots.

Those of us in England who read the society gossip in the daily or the weekly press—or perhaps it would be more accurate to say those of us whose wives do so—are aware that the practical joke is not unknown in "high life"—among people, that is to say, who have nothing better to do. But such joking is very rarely more than a mild inconvenience to the victims, and frequently a source of amusement to spectators. It is rather a shock therefore to learn that in America the practical joker penetrates the industrial sphere—where, as might be expected, he is a good deal more dangerous. Recent statistics from Pennsylvania show that practical jokes have in fact been responsible lately for a number of serious accidents and some fatal ones. It is possibly one of the minor advantages of an older country that its people are apt to draw a sharp line between work and play, especially in such a matter as this.

* * *

With all due modesty, may "Marksman" be permitted to claim a bull's eye? No one can have failed to notice the sudden appearance in all sections of the Press within the last few weeks of a hitherto almost unknown entity—"the small investor"—and concurrently a veritable spate of financial notes and news, couched in terms more or less comprehensible to the lay mind, and all apparently intended to assist this strange new abstraction in the disposal of his surplus wealth. Now did not "Marksman" several months ago furnish his readers with financial advice? Did he not invite correspondence on financial matters? And is this not evidence of very remarkable foresight and perspicuity? Indeed, "Marksman" might not unreasonably go further and claim credit for having started the fashion . . . . but being modest, he will refrain. . . . . .

* * *

Incidentally, "the small investor" would seem to possess certain affinities with that other intangible abstraction, "the man in the street," or even with his predecessor, "the economic man," that worst invention of the dismal science. Who, or what, is the small investor? Must he be less than a given height or weight, must he invest less than a given sum, or what is the qualification? Am I a small investor? Are you a small investor? At what point does the small investor become the large investor, and is the change marked by any corresponding physical transformation? It has frequently been remarked that many successful financiers have the air of being well-fed men—can it be that there is indeed some such relationship? It would in any case be interesting to find out more about this strange creature—why doesn't somebody start a ballot, or a census, or a competition of some sort in order to ascertain the tastes, habits, dietary, hobbies, and so forth, of all those qualifying for the title?

* * *

If you are not yet tired of nigger stories, there is the entertaining one of the coloured gentleman who was faced with the prospect of undesired army service during the war. Acting upon well-meant advice from a white friend, he had all his teeth extracted in an endeavour to escape. In due course he came up for examination, and meeting his friend shortly after was asked if the ruse had succeeded. Sam appeared very doleful. His teeth had vanished, and his speech was not too clear. Yes, he had escaped the draft. "Having your teeth out did the trick, I suppose?" his friend asked. "No, suh, boss," Sam replied, "dey nebber looked at my mouth. Flat feet."

* * *

And do you know this rather technical one? George had recently left school and started work in an engineering shop. His father realised that some degree of polite interest was expected of him, although engineering was hardly in his line. "I'm working in thous now," boasted George. "And what may they be?" his father inquired. George hesitated. "Well, I don't exactly know," he confessed, "but there's many a hundred of them to an inch."

Marksman.

The Causes of Failure of Wrought-Iron Chain and Cable.*

By H. J. Gough, M.B.E., D.Sc., Ph.D., and A. J. Murphy, M.Sc.

For many years wrought iron has been used extensively for the manufacture of chains and cables. It possesses excellent welding and corrosion-resisting properties, and is extremely ductile. The latter property is of extreme importance in lifting-gear chain or cable, with which type engineers are chiefly concerned. In the event of the application of an unusually heavy static load, or of a shock load (often caused by a snatch or sling movement) a well-made chain in normal condition will deform considerably (thus giving visible warning) and will absorb a large amount of energy before finally fracturing. There is a long record of cases, however, where a chain has behaved in an extremely *brittle* manner. Such failures usually occur under shock loading, often of a magnitude absurdly small in comparison with the normal capacity of the chain; for example, many cable links have fractured when the chain has been dropped into a chain-hold for stowage. Fig. 1 shows a link which failed in this manner. It will be seen that the link has snapped off "short." The appearance of the face of the fracture is shown in Fig 2, which shows that it is clearly not a "fatigue" failure. Moreover, had it failed by fatigue it must have done so under a cycle of repeated tensile loading which, in a ductile material like wrought iron, would have produced considerable deformation of the link as a whole. In the majority of failures, the shape of the link shows that practically *no* total deformation has occurred. Many links, after failure, have been submitted to a careful mechanical and metallurgical examination. Test-pieces cut from the interior of the link have shown test properties and microstructure comparable with those of wrought iron in its most ductile state. The cure adopted for many years for such a brittle state is a prolonged low-temperature annealing treatment (at a dull red heat, 650 deg. C. to 750 deg. C.) followed by slow cooling. The origin of this treatment is obscure and the practice has developed simply as the result of wide experience; in some cases, periodic annealing is a statutory requirement. The view held by many chain smiths on the cause of brittleness and the effect of annealing is that the iron tends in service to become crystallised, a condition which is removed by the annealing process. In view of the facts that the material is originally in a finely-divided crystalline state, and that the critical point for normal wrought iron is in the neighbourhood of 900 deg. C., this explanation cannot be correct. In many instances sudden chain failures have involved fatal accidents and it became imperative, in the interests of public safety, that the causes of chain failure should be investigated in a systematic manner. A recommendation that such an investigation should be carried out was forwarded by the Home Office to the Department of Scientific and Industrial Research, and in the autumn of 1924 an experimental investigation was commenced at the National Physical Laboratory.

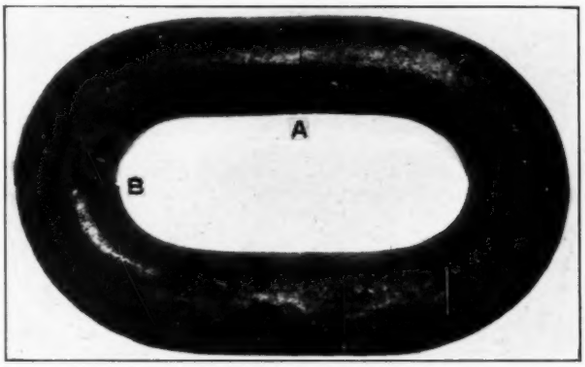


Fig. 1.—Link 3⅛ in. Diameter, 20 in. Long, Studded.
A = Failure in Service. B = Saw Cut.

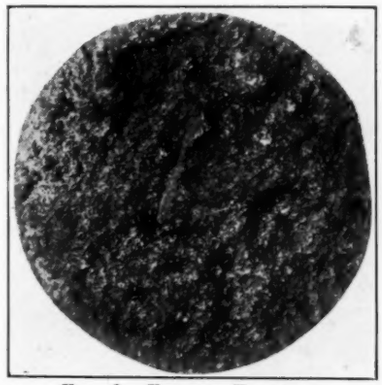
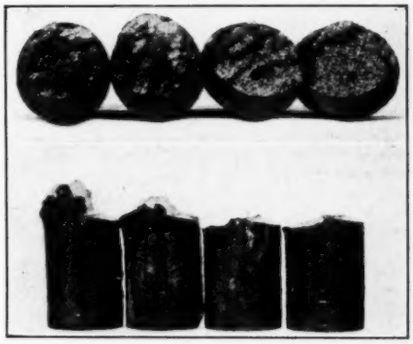


Fig. 2.—Face of Fracture.



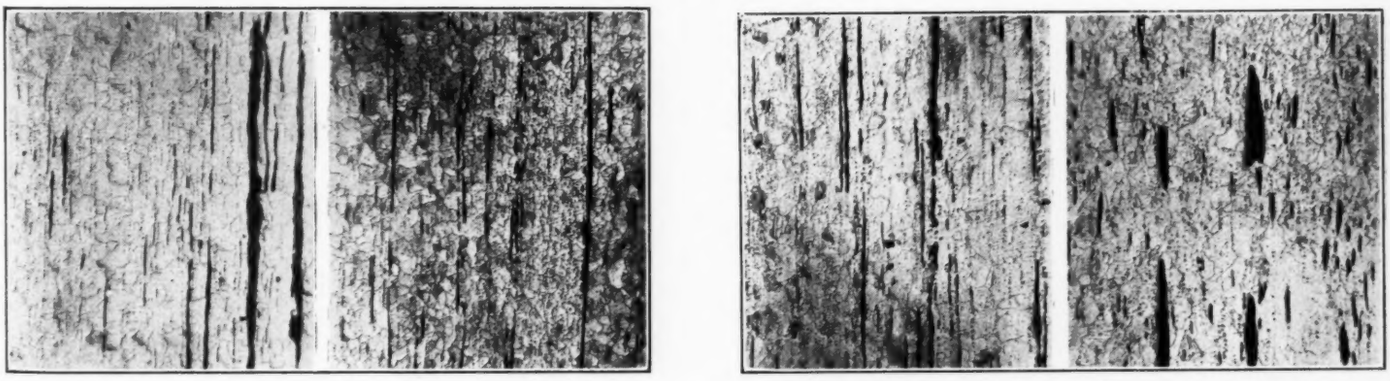
Bar No. A1 A2 A3 A4
Fig. 3.—Broken Bars.

Fig. 5.—Fractured Link of 1¼-in. Crane Chain, showing "Burnt" Pilings.
Note positions of cracks on inner surface of link.

A very lengthy research programme has now been completed and the full report† is in course of publication. In view of the voluminous nature of this report and of the importance of the subject to engineers, it was considered that a shorter account of the results of the research should be communicated elsewhere, and the present Paper has therefore been prepared.

Failures and Characteristics of Overheated Wrought Iron.

There is no doubt that overheating wrought iron produces extreme brittleness which cannot be removed by any subsequent heat-treatment. In experiments made on this point four bars of best-quality wrought iron (Reference Mark CRK)



A1.—Heated to 1,100 deg. C. A2.—Heated to 1,200 deg C. A3.—Heated to 1,300 deg. C. A4.—Heated to 1,400 deg. C.

Fig. 4.—Microstructure on Longitudinal Sections of Bars.
(*Magnified 30 diameters*).

* A paper read before the Institution of Mechanical Engineers.

† "The Causes of Failure of Wrought Iron Chains," by H. J. Gough and A. J. Murphy, Department of Scientific and Industrial Research, Engineering Research Special Report No. 3, H.M. Stationery Office.

were heated to various temperatures, notched, and broken under hammer blows with the following results:—

Bar.	Temp. Deg. C.	Blows required to fracture.
A 1	1,100	7
A 2	1,200	4
A 3	1,300	2
A 4	1,400	1

Fig. 3 shows the appearance of the broken bars and the varying degree of "crystallinity" exhibited in the fractures. Fig. 4 shows the microstructure on longitudinal sections of these bars. There is no marked difference in grain size between the specimens and no sign of oxidisation in the interior of the metal. The dark elongated inclusions are slag streaks. The large facets seen in the fractures of the overheated

Fig. 6.

A = Ductile fracture. B = Fractured link containing "burnt" outer zone.
C = Link split longitudinally along a "burnt" piling.

material are due to transcrystalline cleavages passing through a number of adjacent crystals with only a slight change of direction. There is thus no doubt that overheated material produces a state of brittleness. Sometimes a chain link as a whole becomes "burnt" during the manufacturing process and the application of a sudden shock to such a link will produce a fracture similar to that seen in Fig. 1. In other cases a fractured link shows the appearance illustrated in Fig. 5. The cross-section contains two or more layers of "burnt" iron, which have been overheated in the puddling or mill furnaces. The intermediate layers are in the normal ductile

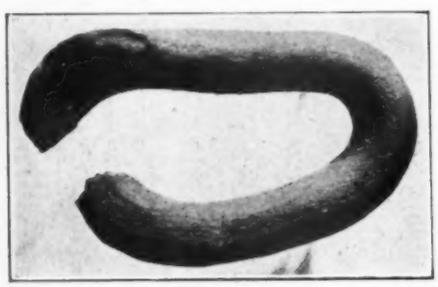


Fig. 7.—"Dirty" Weld.

state. The link illustrated was normalised (heated to 1,000 deg. C. and cooled in air) before testing, and it is thus demonstrated that the overheated material cannot be restored by subsequent heat-treatment of this nature. In other cases, a link made of good iron is overheated on the smith's hearth, producing a "burnt" zone on the surface of the link. Fig. 6 shows examples of this type of defect.

These are general cases of failures due to brittleness caused by overheating, but in these cases the causes of failure can usually be determined from the appearance of the fracture and by the usual tests.

Failures due to Faulty Welds or to Welds which have Deteriorated in Service.

If the weld is made at too low a temperature, or is dirty, or is incompletely closed during manufacture, a very weak joint is obtained offering low resistance to *shock*. Fig. 7 shows an example of a "dirty" weld which has opened up entirely along the scarf. Fig. 8 shows etched cross-sections through welded crowns of new links (¾-in. chain, Reference Mark CDG) showing varying qualities of weld. The manner in which the

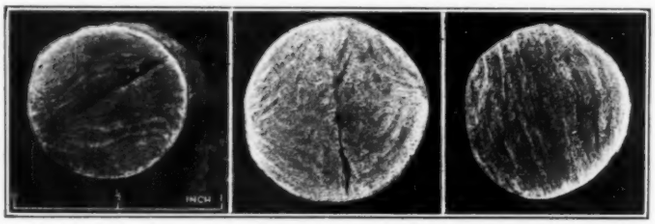


Fig. 8.—Cross-sections through Welded Crowns of New Links.

metal has flowed during working is evident. Attention may here be drawn to a very insidious defect met with in practice. Under repeated shocks received in service, the welded joints tend to separate. Sometimes the scarf opens on the outside; this can be detected by visual examination. A much more dangerous form of deterioration is that in which the weld separates *within* the link. Fig. 9 shows samples cut from a ¾-in. crane chain (Reference Mark CSJ) which has been regularly annealed, tested, and examined during thirteen years' service. The welds are, apparently, in good condition. A minute examination of the exterior of all the links of the chain

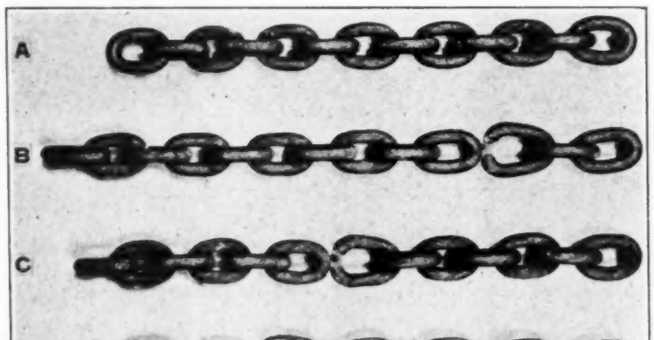


Fig. 9.—Crane Chain ¾-in.

failed to show the slightest sign of scarf movement. This chain easily passed the required static tensile tests (proof load), but when tested under shock, failed at the welded joints, with a low absorption of energy. Sample A shows the chain as received, while samples B, C, and D have been tested (under tensile impact) in the "as received," annealed (650 deg. C.), and normalised (1,000 deg. C.) conditions, respectively. All show weld failures, indicating that heat-treatment cannot cure this dangerous defect to which chains are liable. (A very lengthy series of tests was made on a new chain (Reference Mark CEM) and this progressive deterioration of the weld under repeated shock was reproduced in the Laboratory with results exactly similar to those described above.)

Effect of Repeated Static Straining, with and without intermediate Heat-Treatment, upon the Strength Properties of a Chain, and on the Mechanical Properties and Microstructure of the Iron.

It is well known that overstraining followed by suitable heat-treatment can, in some metals, produce a coarsened grain structure, and the opinion has been expressed that the practice of "periodic" proofing and low-temperature annealing of wrought-iron chains might conceivably lead to such grain growth with the attainment of a state of brittleness. This possibility has been experimentally explored in a very complete manner. The experiments and results may be summarised as follows:—

A new ¾-in. chain (Reference Mark CDG) was used in the tests, and all samples were given a preliminary normalising treatment. These samples were submitted to a combination of static tensile straining with, in some cases, intermediate and, or instead, final heat-treatment. Two standard heat-treatments were employed: (*a*) normalising (heating to 1,000 deg. C., maintaining for 15 minutes at this temperature and finally cooling in air), denoted by N; and (*b*) annealing (heating to 650 deg. C. for one hour, and then cooling in the furnace), denoted by A. The overstraining was performed on an energy basis, the amounts of energy absorbed in samples containing ten links in the first, second and third overstrainings being adjusted to 4.7, 3.6 and 2.5 inch-tons respectively. (These are equivalent to the energies absorbed during a single application of a tensile load of 10 tons.) The complete programme of treatments used is in Fig. 10, where O denotes overstraining.

Tests were also made on samples in the "as received," annealed, and normalised conditions for purposes of comparison. Each of the samples used consisted of a length of ten links. After the required treatment, the sample was cut up to provide:—(*a*) A length of six links for static tensile tests to destruction; (*b*) four separate links, which were cut up to provide small specimens for (i) complete static tensile test, (ii) impact-

tensile tests, (iii) notched-bar and Brinell hardness tests, and (iv) microscopical examination.

All tests were in quadruplicate. In Figs. 10 and 11 the principal results are expressed

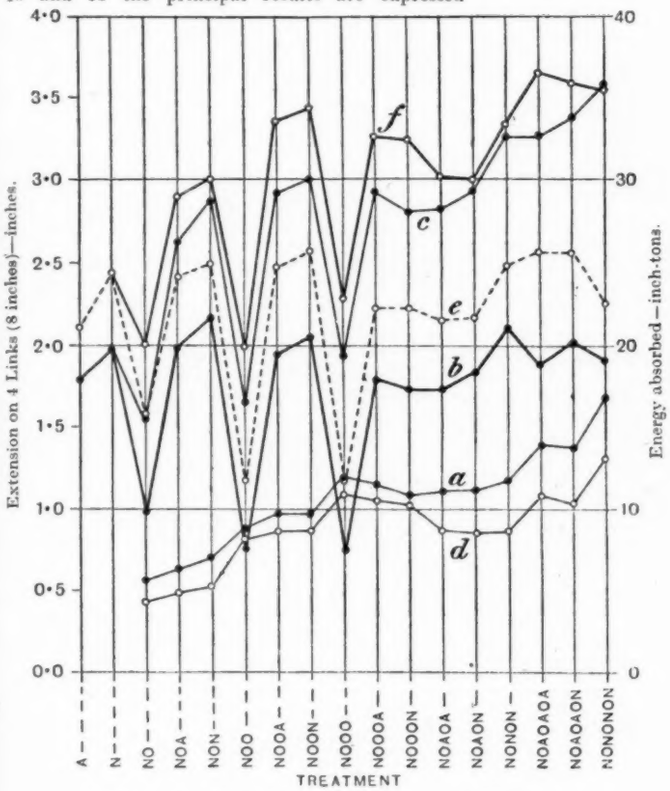


FIG. 10.—RESULTS OF STATIC TENSILE TESTS ON OVERSTRAINED ¾-IN. CHAIN.

Curve *a*.—Extension in Overstraining Test.
" *b*.— " " Test to Destruction.
" *c*.—Total Extension.
" *d*.—Energy absorbed in Overstraining.
" *e*.— " " " Destruction Test.
" *f*.—Total Energy absorbed.

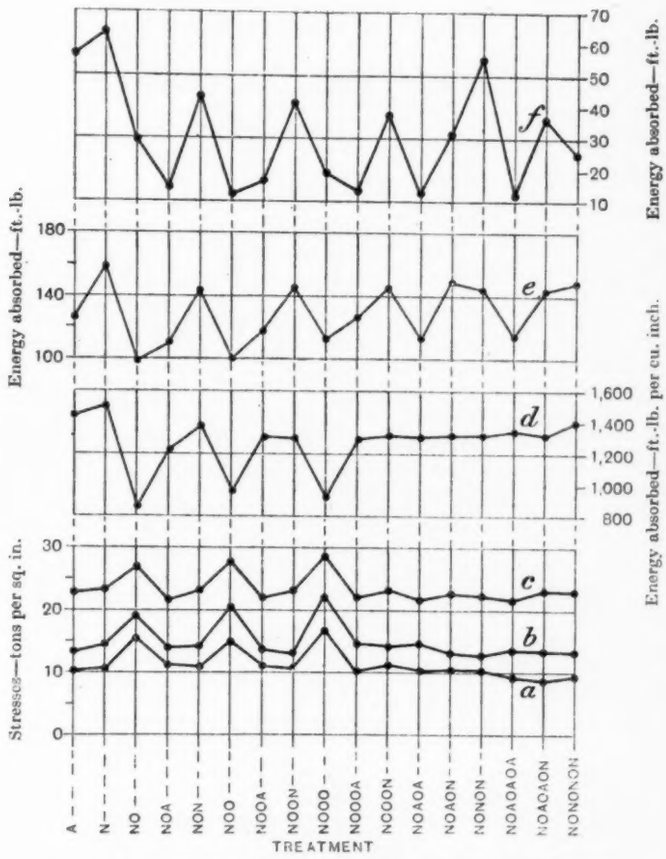


FIG. 11.—RESULTS OF MECHANICAL TESTS ON SMALL SPECIMENS CUT FROM THE CHAIN LINKS.

Curve *a*—Tensile Limit of Proportionality.
" *b*.— " Yield Stress.
" *c*.—Ultimate Tensile Strength.
" *d*.—Energy absorbed to fracture in Static Tensile Test.
" *e*.— " " in Impact Tensile Test (Un-notched specimens).
" *f*.—Results of Charpy (Beam) Impact Tests. (Notched specimens).

(1) One, two, and three overstrainings (NO, NOO, NOOO). (2) As (1), with a final annealing treatment (NOA, NOOA, NOOOA). (3) As (1), with a final normalising treatment (NON, NOON, NOOON). (4) Two and three overstrainings with intermediate and final annealing treatments (NOAOA, NOAOAOA). (5) As (4), but with normalising substituted for annealing (NONON, NONONON). (6) Two and three overstrainings with intermediate annealing and final normalising treatments (NOAON, NOAOAON).

graphically. It will be seen that the usual strain-hardening effects due to the overstraining are clearly demonstrated, but that annealing or normalising is very effective in restoring the material to its original ductile state. In Fig. 10 attention is especially directed to the value of the energy absorbed to fracture in the final test to destruction. *The chief result of the tests is to show that repeated overstraining and low-temperature annealing applied to a wrought-iron chain does not produce any "shortness" or "brittleness"—as disclosed by static tensile tests—but, on the contrary, it induces a state of great ductility.* Fig. 11 shows that the mechanical tests on specimens cut from the links reflect broadly the above conclusions deduced from the behaviour of the chain. The notched-bar test results, however, show that annealing following overstraining did not restore the notched-bar value; in fact, in some cases a further drop in notched-bar value resulted from the annealing. It appears entirely contrary to the ductile nature of the material after such annealing and to general experience of the behaviour of annealed chains in service, to suppose that the characteristics revealed by the notched-bar test would be reflected in the behaviour of chain lengths tested under shock conditions. The matter was investigated, however, in a thorough manner, by a series of tests. A new 1¼-in. open-link chain (Reference Mark CET) was used, which possessed welded scarves of a very high and uniform quality. A number of samples, each containing eight links, was overstrained by a static tensile load of 28 tons (this is exactly equivalent to the load of 10 tons applied to the

(*Continued on page* 353.)

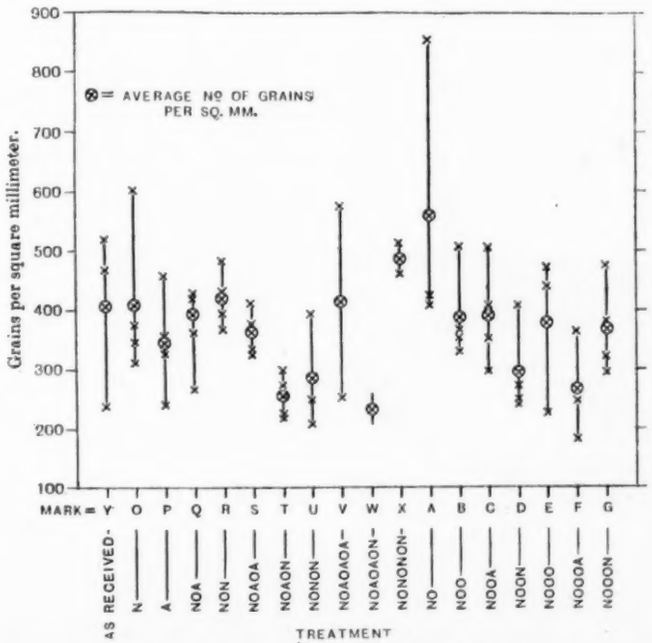


FIG. 12.—GRAIN SIZE IN SAMPLES OF ¾-IN. CHAIN.
(*For markings see under Figs.* 10 *and* 11.)

Institute of British Foundrymen.

Birmingham Branch Annual General Meeting and Discussion on Testing.

At the annual meeting of the Birmingham Branch of the Institute of British Foundrymen, held at the Engineers' Club on April 19, Mr. F. G. Starr was re-elected President. Mr. E. H. Tyson, who proposed him, said Mr. Starr had displayed a very active interest in the welfare of the Branch. In seconding, Mr. D. Wilkinson mentioned that the President had been very keen on propaganda work. For the offices of senior and junior Vice-Presidents Mr. Tyson and Mr. Wilkinson were appointed, on the motion of Mr. E. R. Taylor, seconded by Mr. E. J. Lewis. The President proposed that Mr. F. K. Neath, B.Sc., be re-elected Hon. Secretary, saying that they could not find anyone who would do the work of the Branch better. Mr. Neath put in a lot of time and went to a good deal of trouble in carrying out his duties, which he performed most efficiently. Mr. F. J. Rowe seconded, and Mr. J. G. Pearce supported, and the motion was carried unanimously. It was also decided that owing to Mr. E. Dicks resigning the office of Treasurer, Mr. Neath should combine the two offices. Mr. H. S. Morgan moved that Messrs. Edwards, Johnson, Wood and Tyson be reappointed delegates to the General Council, and Mr. W. James seconded. This was carried, though Mr. F. C. Edwards offered to stand down if anyone else desired to act. There were no retiring members from the Branch Council, occasional vacancies having been filled up in previous years for the full period of three years. It was felt that a proportion should retire each year as ordered by rule, and the matter is to be reconsidered to restore the position. Mr. F. J. Cook proposed a vote of thanks to the officers and Council for their services, which was carried; and Mr. Flavell, in order to create more interest in the Branch meetings, asked whether anyone wished to make suggestions as to the nature of the lectures which might be arranged. Mr. Pearce indicated what might be done if desired, and the President then announced that the Council would consider the question. It was noticed by Mr. Lewis with great satisfaction that the attendance at the Junior section lectures was from 60 to 75 per cent.

The National Specification for Grey-Iron Castings.

There was considerable discussion on a lecture, illustrated with lantern slides, which was given on "The New National Specification for Grey-Iron Castings," by Mr. J. G. Pearce, B.Sc., Director of the British Cast-Iron Research Association, who went through the specification clause by clause and explained the various features and the reasons which had prompted their adoption.

The President (Mr. Starr) remarked that looking at the specification broadly, it would seem that the specification would be very acceptable to the foundry industry, although it remained to be seen how things turned out in practice.

Shear Test Condemned.

Mr. F. J. Cook considered that the Institute ought to be congratulated, because it was at the instigation of that body that this investigation was begun and the specification arrived at. It was felt, however, that unless they could secure the co-operation of the B.E.S.A. any conclusions reached would not be accepted in the country. Consequently a Committee of the B.C.I.R.A. had joined with them, and he might say that the Committee members had worked very hard to keep the foundrymen's point of view to the fore. As regards the shearing test mentioned by Mr. Pearce, he might inform them that there had been a Committee of the Institute doing quite a lot of work in the investigation of this test, and as a result of their efforts he thought there would be sufficient evidence forthcoming at the next international meeting to condemn it so far as this country was concerned. The lecturer seemed to issue a challenge as to whether a bar was stronger machined or unmachined. His experience was that they could answer "both," as it largely depended on the class of work being done. Mr. Cook proceeded to give an illustration of tensile and transverse strength and hardness, showing that as hardness increased the strength went up also until the loop of the diagram was reached, when they came down. He found that they could get the same tensile strength with a wide difference in hardness. One section would be weak because it was soft, and another section weak because brittle. They could undoubtedly get a stronger bar by casting it too big and machining it down.

Influence of Directional Castings.

Mr. F. C. Edwards said that the position of the bar in the mould when casting and the way in which it lay had an effect on the strength of the bar. In his experience a horiontal bar was generally the stronger. So many factors entered into a cast-iron casting, however, that to concentrate on one factor only was misleading. To carry out tests thoroughly one required the sand and mould to be a certain temperature, and the cooling also had to be watched. Shear testing he considered unsatisfactory. Suppose a big casting was drilled and a core taken out. It looked a simple test, but a lot depended on the cutting ability of the drill, how it was lubricated, and the speed at which it ran. Drilling generated a certain amount of heat, and the core might become very much weakened by drilling out of the lump. Neither was shearing a fair test, because they wanted to get somewhere near the thickness of the casting. On the whole he thought the three bars laid down were very good, although the method of pouring and the position of the bar in the mould were not specified.

Mr. E. R. Taylor considered that one definite thing in favour of the French method of testing was its lower cost. The preparation of test bars was a costly matter, whereas trepanning a piece out was quite simple. Apart from the merits or otherwise of the shear test, each casting could be tested.

Mr. D. Wilkinson remarked that inspectors frequently wanted to know what a casting would stand, and stated that there was only one way of finding out: that was by breaking it. It could not be insisted on too strongly that it was necessary to test the grade of metal put into a casting, and to do so under conditions as near as possible to those in ordinary working. The present specifications were therefore a step in the right direction. It was no use testing a light casting with a big bar, or *vice versa;* hence, the three sizes were required. The rate of cooling of a big casting would alter the whole texture of the metal in a small bar, for instance, and the same applied if the case was reversed. It was essential to ensure a sound test that the bar should cool as near as possible at the same rate as the casting, and that the conditions for the test, which was an actual test of the metal, should be approximately the same as for the casting itself, but not influenced by the casting. If a designer put forward a casting that would not give satisfactory results, provided a certain grade of metal was put into it, then it was really no concern of the foundryman. An engineer had no right to demand that a test bar should be made which would give a metal different from that of the actual casting. The performance of a casting in work was really the concern of the engineer and designer, and the strength and grade of the metal was the concern of the foundryman. If the engineer sent a design for an irregular or awkwardly-shaped casting, it was surely his fault if the metal, otherwise really good metal, became altered in its strength. Three different sizes of test bars, with stringent specifications to ensure that the metal used was the same for the castings, was one of the needs of the industry. Unfortunately the average designer did not care to have his design questioned. Nevertheless it was the foundryman's duty to point out what he considered a defect of a design in its bearing on good casting.

Mr. M. H. Curnow asked whether the inspector was to be at the foundry when the tests were made, and also inquired if foundrymen were to be allowed to make those little adjustments which were found to be necessary to turn out a good casting.

Mr. G. M. Callaghan, observing that the literature on tests did not say very much about hydraulic work and air pressure, asked was there any instruction in such tests. Also when the foundry received orders for cylinders and so forth and had to put a head on, who was responsible for machining the head?

Mr. T. H. Turner said that no doubt it was a useful specification as a beginning, though it was a little unfortunate that the highest quality taken was grade "A," because already irons were being made of twice its tensile strength. However, if "A" and "B" were taken as the lowest grades, they could go on improving. Alluding to the paragraph covering "out of twist, distortion, blow holes, and surface defects," and to castings being machinable, Mr. Turner asked could Mr. Pearce explain what was the actual difference between out of twist and distortion, as there must surely be some recognised meaning.

Author's Reply.

Mr. Pearce, in reply, agreed that Mr. Edwards should cast test bars horizontally. It was always preferable to leave the method of casting to the moulder, and hence the specification did not lay down any rule on the point. It was left to the discretion of the moulder, because it was the common experience that if they tried to tell a moulder how to make a casting, he turned out a worse one than if he were left alone. Regarding Mr. Taylor's argument on the cheapness of the French test, it was not quite such a simple matter as would appear, inasmuch as he was confining the test to one trepanning. Yet they might require half-a-dozen such tests to explore the casting at different points. Then as regards machining, the drill finish was coarse. If they had found out one thing about shear testing it was that they must have the finest possible finish, and no slack or play between the test bar and the shackles in which it was tested. It was by no means a cheap test.

Mr. Pearce next said he was very largely in sympathy with the remarks of Mr. Wilkinson, but could not go quite all the way with him. It seemed that the designer could sometimes produce a workable, metallurgically-sound design, and the foundry could put into it extremely good metal, and yet the result might not be satisfactory. Because, as they knew, there were other factors which the foundry could control, melting and moulding and so forth, which lay outside the province of good metal and good design. He understood that Mr. Curnow desired a continuance of that little bit of leeway which had sometimes been necessary because the engineer cut off his nose to spite his face. It had been in the past necessary in the engineer's own interest to do a certain amount of "wangling," but with this specification this would not be needed. It was a perfectly straight specification, and they would not require to introduce "the little tricks of the trade" which had taught the foundry industry so much in the past. As to hydraulic and air tests, this was a general specification for common iron castings for whatever the engineer liked to use it. It was not intended for non-engineering castings, like builders' castings, or special castings, like hydraulic and pneumatic castings, or for other specialised castings for which the B.E.S.A. already has specifications, motor cylinders, pistons and piston rings, for example, or for railway requirements which had their own specifications also. There was no intention whatever of displacing other specifications. He believed the day would come when they must get away from mechanical tests for cast iron and establish a new technique of casting. In due course they would be able to predict strength from structure without any mechanical tests, but at present they were in the hands of the engineers, who were their customers. Regarding the point of quality raised by Mr. Turner, they must view the question broadly and from the aspect of general requirements. This

was a general specification, and not one for a specialised or high-quality iron of the kind used for special service conditions. Nothing was said in the specification about the transverse bar which was not quite round, just as others said nothing about the transverse bar which was not quite square. If an inspector raised the point then they would have to take the major dimensions. Modern foundries which adopted the practice of taking regular tests and keeping a log had these records accepted by inspectors. While there was no stipulation about test bars being machined if over size, in cases where a lot was machined off it was rather against the maker up. It was somewhat curious that Mr. Turner should comment on the terms "out of twist and distortion." Other words in the specification covered the phrase, and the term "out of twist" did not mean what they and he might think—out of its normal shape. It actually meant "not twisted." The Admiralty view was that out of twist was really "not twisted," free from distortion or not warped. It was put in, just as were certain terms in a legal document, to cover every conceivable possibility which might cause the rejection of a casting, and was a matter of established custom.

Newcastle Foundrymen Visit Marley Hill Coke Ovens.

The Newcastle and District Branch of the Institute of British Foundrymen recently visited the coke plant of the Marley Hill Chemical Company, Limited. The party was received by the manager, Mr. William Diamond, who conducted them round the plant. The members were afterwards entertained to tea by the company.

The coal carbonisation plant of the Marley Hill Chemical Company comprises 90 ovens of the Huessener type, forming two batteries of 60 ovens and 30 ovens. The latter battery was built to a slightly different design, being semi-regenerative and having also a greater capacity per oven.

The major part of the coke manufactured is for foundry purposes, and to obtain the necessary high quality of coke great care is taken in selecting the coal, which is subsequently treated in the coal washery and on picking belts to eliminate any free dirt or matter which may by chance have a bad effect on the coal during carbonisation. The coal, after being washed and thoroughly cleaned, is thrown into large ferro-concrete bunkers, each having a capacity of about 3,000 tons.

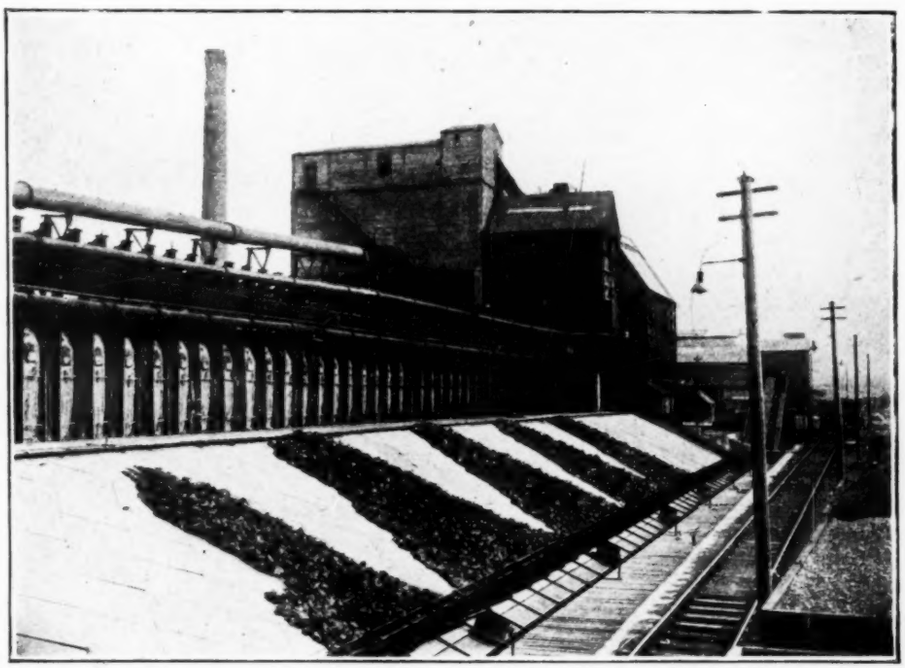
After the coal has remained in these bunkers for a time, so that the moisture content is reduced by drainage, it is then conveyed by suitable mechanism to high-speed crushing machines. A screening test of the coal after having passed through this machine shows that 90 per cent. is small enough to pass through ⅛-in. mesh. The coal is then conveyed into bunkers, whence it passes to the stamping machine. The latter is comprised of a chamber 35 ft. long, 20 in. wide, and 7 ft. 6 in. deep, into which the coal is fed until the bottom is covered with a layer. From this point the coal is gradually poured in till the box contains a full charge, a solid mass or "cake" of compressed coal. The bottom of the box is a "peel" on which the stamped charge is carried into the oven. The "peel" is immediately extracted.

When the oven is charged the two doors at both ends of the oven are hermetically sealed; the heat transmitted through the side walls distills the coal, which is converted into coke in approximately 24 hours.

The gases evolved in the process have been meanwhile subjected to chemical treatment, and benzol and all its homologues, also ammonia which is converted into ammonia compounds, are extracted.

When the coke is ready for discharge from the oven, a mechanical ram apparatus pushes the charge out on to an inclined bench, where it is quenched by a rapid supply of water, the object being to quench the coke as quickly as possible and so give it a good colour. If the air touches the surface of the coke, it gives the latter a dark appearance, which is not very pleasing.

The by-product and chemical plants forming the remainder of this company's works are extensive, making various chemicals from the tar products and sulphuric acid.



COKE BENCH NO. 1 BATTERY.—THE MARLEY HILL CHEMICAL COMPANY, LIMITED.

The Universal System of Machine Moulding and Machinery Company, Limited, of 13-15, Wilson Street, London, E.C.2, have recently been granted the exclusive selling rights for aluminium pressure die-casting machines manufactured under Patents Nos. 203399 and 204743. These machines can be seen in actual operation in the Birmingham district by interested parties at any time convenient to them. These machines are of the greatest interest to all aluminium founders.

The Causes of Failure of Wrought-Iron Chain and Cable.

(Continued from page 351.)

¾-in. chain in the previous tests). Some samples were then annealed and others were normalised. These three conditions will be distinguished by the symbols, O, OA, and ON. Samples in each condition were then tested to destruction by shock loading (tensile impact in the railway-coupling testing machine). From other samples notched-bar test-pieces were cut. The results obtained, which represent the average of tests on eight samples, are summarised in Table I.

TABLE I.—*Tests on 1¼-in. New Chain (Reference Marks CET) overstrained in Static Tension and Tested to Destruction under Shock (Impact-Tensile).*

Test.	Test data.	Treatment. As received.	Overstrained (O).	Overstrained and annealed (OA)	Overstrained and normalised (ON)
Shock tests to destruction on chain lengths (impact-tensile)	Energy absorbed to fracture, inch-tons.	23.9	18.7	24.8	32.8
	Average extension per link after test, inches.	0.63	0.43	0.80	0.99
Notched-bar tests on specimens cut from links.	Energy absorbed to fracture, ft.-lbs.	50	41	20	45

The notched-bar test results reproduce exactly the features of those of the previous experiments on ¾-in. chain. The overstraining (O) causes a reduction in the value of the energy absorbed which a subsequent annealing still further reduced by 50 per cent. This behaviour is confined, however, to these test specimens; it is certainly not reflected in the behaviour of the chain when tested to destruction, as a whole, under shock. On the contrary, it is found that the annealing treatment has conferred additional ductility on the material and has at least removed the strain-hardening due to the overstraining. The exact significance of the notched-bar test is still obscure and the above tests are regarded as decisive evidence that annealing following overstraining does *not* reduce the resistance of the chain to shock, but increases these shock-resisting properties.

Returning to the tests on the ¾-in. chain, two transverse sections were cut from the end of each of two links of every chain sample employed. Very careful grain counts were made on these sections after polishing and etching. The results of these counts are given in Fig. 12. As would be expected, wide variations in grain size exist in any one sample of wrought iron, and this presents some difficulty in estimating the effect of different treatments on grain size. It is evident, nevertheless, that with the conditions of overstraining and with the heat-treatments employed corresponding changes in grain size are *not* produced and, more important still, that no combination of overstraining and annealing has produced a coarsened structure. Now the specimen for microstructure represented a complete section of the link taken at the crown and had been subjected to strains varying from a maximum compression, through zero, to a maximum tensile strain. At no point, therefore, had the strain been critical with regard to the heat-treatment used. In other experiments made on tapered test-pieces the authors were unable to produce any coarsened grain growth by a combination of strain up to 16 per cent. elongation and subsequent annealing at 650 deg. C.

Thus, it will be seen that the experiments failed completely to produce a state of brittleness by any combination of static straining and annealing at 650 deg. On the contrary, annealing was found to be extremely beneficial in restoring overstrained material to a condition nearly approaching its original ductile state.

(To be continued.)

Belgian Import Duty on Special Steels.—The Belgian Government intends to increase the import duty on special steels from present 5 per cent. ad valorem to 15 per cent.

Second Report on the Heterogeneity of Steel Ingots.*

By a Committee of the Iron and Steel Institute.

(Abridged.)

Subsequent to the presentation of the First Report (May, 1926),* the Committee on Heterogeneity of Steel Ingots has been enlarged by the co-option of several gentlemen, able to assist materially in the continued investigations, and the Committee is now constituted as follows:—

Professor J. H. Andrew (Royal Technical College, Glasgow).
Mr. G. W. Austin (R.N. Torpedo Factory, Greenock).
Professor H. C. H. Carpenter, F.R.S. (Royal School of Mines, London).
Mr. T. P. Colclough (The Park Gate Iron and Steel Company, Limited).
Mr. W. J. Dawson (Messrs. Hadfields, Limited).
Professor C. H. Desch, F.R.S. (The University, Sheffield).
Mr. J. H. S. Dickenson (Messrs. Vickers-Armstrongs, Limited)—*Vice-Chairman.*
Mr. A. P. Hague (Messrs. Cammell Laird & Company, Limited).
Dr. W. H. Hatfield (The Brown-Firth Research Laboratories)—*Chairman.*
Mr. E. F. Law (Messrs. Vickers-Armstrongs, Limited).
Mr. S. A. Main (Messrs. Hadfields, Limited).
Dr. H. Moore, O.B.E. Research Department, Woolwich).
Mr. T. M. Service (Messrs. Wm. Beardmore & Company, Limited).
Mr. H. Sutton (Royal Aircraft Establishment, Farnborough).
Mr. J. H. Whiteley (The South Durham Steel and Iron Company, Limited).

The Committee now presents its Second Report, which is confined to a consideration of further types of carbon-steel ingots, and to several examples of alloy-steel ingots. Consideration is also given to the subject of ingot moulds. Scientific investigations are in hand with a view to the elucidation of matters arising out of the first general research. The whole of the work has been made possible through the generosity of the firms with which some of the members are associated, in supplying data, and in facilitating and financing a most costly form of investigation, whilst for the last-mentioned investigations the Iron and Steel Institute is providing the necessary funds.

* A Paper read before the May Meeting of the Iron and Steel Institute.

I.—Introduction.

The First Report dealt with carbon-steel ingots of various sizes, the steel having been so refined that gases given off during the freezing of the ingot did not produce blow-holes—*i.e.*, all the steel was of the "killed" type, and, consequently, the ingots were of the sound type. The researches of the Committee showed, however, that all the ingots, although representing good normal production, disclosed definite heterogeneity as regards the distribution of the carbon, sulphur, and phosphorus, and further, that the degree of heterogeneity increased with increase in the mass of the ingot. It was suggested that these variations in composition were due to the manner in which the liquid steel solidified, and whilst Section IV of the First Report was devoted to a consideration of the influence of the various factors involved, and to a tentative discussion of certain theories in explanation of the observed facts, it was realised that much research was necessary before any attempt could be made to give a complete picture of the mechanism of freezing. In certain directions the Committee had since been able to provide for the execution of several much-needed investigations. Until this work is more advanced the Committee proposes to abstain from a further theoretical dissertation upon the results, and this Second Report will be confined, as far as possible, to a statement of the essential facts determined.

An account is given of alloy-steel ingots produced from fully-killed steel containing nickel, nickel and chromium, and nickel, chromium, and molybdenum; whilst in one case the distribution of a small quantity of copper present in the ingot is studied. Incidentally, the temperatures permissible in the hot-working of such not so readily weldable steels do not permit of raising them to welding heats, and it is therefore imperative that the ingot material shall be free from cavity of any kind. The ingots studied indicate that a high technical standard has been attained in the production of such material.

II.—Ingot Moulds.

Of the factors influencing the characteristics of the ingot, the form of mould employed is necessarily one of the most important. It was therefore considered that the presentation of adequate data concerning the design and general details of the moulds used would enhance the value of the results of the researches on the ingots themselves.

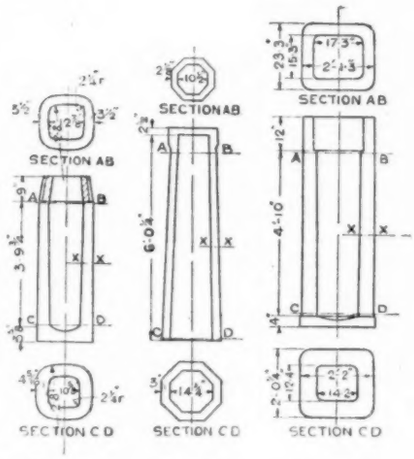


Fig. 1.—Mould A. Fig. 2.—Mould B. Fig. 3.—Mould C.

	Mould A. Lbs.	Mould B. Lbs.	Mould C. Lbs.
Weight of steel covered by 1 sq. ft. of mould at XX	121	126	151
Weight of mould per sq. ft. of surface of ingot at XX	178	111	308
	Sq. in.	Sq. in.	Sq. in.
Sectional area of ingot at AB	151	87	264
Sectional area of ingot at CD	105	173	168
Sectional area of mould at AB	195	89	313
Sectional area of mould at CD	215	176	448
	Cwts. qrs. lbs.	Tons cwts. qrs.	Tons cwts.
Total weight of ingot	15 3 0	1 3 1	1 15
Weight of mould	—	1 1 3	—
Weight of chill portion of ingot	13 1 5	—	1 11
Weight of chill portion of mould	18 0 0	—	2 11

Table I.—*Mould Details* (*see Figs.* 1 *to* 9).

Mould Symbol.	Ingot. Total weight. Tons cwts. qrs. lbs.	Ingot. Weight in chill. Tons cwts. qrs. lbs.	Ingot. Weight of feeder. Tons cwts. qrs. lbs.	Mould. Shape.	Mould. Purpose.	Mould. Weight of chill. Tons cwts. qrs. lbs.	Ratio of weight of chill to weight of steel in chill. Per cent.	Weight of mould per sq. ft. of surface at XX. Lbs.	Weight of steel covered by 1 sq. ft. of mould at XX. Lbs.	Ratio of weight of mould to weight of steel. Per cent.	Ingot. Example Number
A	0 15 3 0	0 13 1 5	0 2 1 23	Square ..	Alloy steel ..	0 18 0 0	135	178	121	147	17
B	1 3 1 0	1 3 1 0	—	Octagonal ..	Rly. carbon steel.	1 1 3 0	93	111	126	89	32
C	1 15 0 0	1 11 0 0	0 4 0 0	Square ..	Alloy steel ..	2 11 0 0	164	308	151	204	—
D	2 4 0 0	1 16 2 0	0 7 2 0	Square ..	Alloy steel	4 3 0 0	227	286.5	159	180	19 & 20
E	2 16 0 0	2 0 3 0	0 15 1 0	Rectangular	Rly. carbon steel.	2 7 3 0	117	223	191	116	4*
F	2 17 0 0	2 7 3 14	0 9 0 14	Square ..	Alloy steel	4 15 0 7	198	263	197	133	18
G	2 18 2 0	2 11 0 0	0 7 2 0	Rectangular	Plate steel ..	3 10 0 0	137	218	202	108	5*
H	2 18 0 0	2 11 0 0	0 7 0 0	Twelve-sided	Carbon steel	3 2 0 0	121	194	200	97	6*
I	3 6 0 0	2 16 0 0	0 10 0 0	Square ..	Billet steel ..	3 11 0 0	127	204	206	—	29
J	6 15 0 0	6 15 0 0	—	Rectangular	Plate steel ..	5 3 0 0	76	206	301	68	25 & 27
K	7 15 0 0	7 15 0 0	—	Rectangular	Plate steel ..	7 11 0 0	97	258	312	82	26
L	7 14 0 0	7 14 0 0	—	Rectangular	Plate steel ..	7 16 0 0	101	277	287	—	30 & 31
M	8 0 0 0	8 0 0 0	—	Rectangular	Plate steel ..	—	—	258	303	85	8* & 28
N	9 7 3 0	8 1 0 0	1 6 3 0	Octagonal ..	Alloy steel	9 3 0 0	126	392	347	113	—
O	17 12 0 0	15 7 0 0	2 5 0 0	Octagonal ..	Alloy steel ..	18 9 0 0	120	377	315	119	11*
P	25 0 0 0	18 15 0 0	6 5 0 0	Octagonal ..	Alloy steel ..	17 15 0 0	94	408	414	98	12*
Q	50 3 0 0	40 8 0 0	9 15 0 0	Round ..	Alloy steel ..	41 4 0 0	101	—	—	—	22
R	119 10 0 0	96 10 0 0	23 0 0 0	Octagonal ..	Alloy steel ..	64 2 0 0	66	—	—	—	23

* See First Report.

Particulars are now given of some of the moulds used for the ingots described in the First Report, and for each of these dealt with in the present Report; brief details are given in Table I, and dimensioned drawings are given in Figs. 1 to 18 in the Report. [Of which those relating to moulds A, B, C, J, K, L, M, Q, and R in Table I have been selected as typical for reproduction in this abstract.]

Material of the Moulds.—All the moulds at present under examination by the Committee are made of cast iron, which material meets, to a reasonable degree, the demand as regards physical properties, maintenance, and cheapness. Steel moulds are used to some extent, and it is quite realised that further investigation may indicate possibilities of development, for special cases, in the material of the mould. As indicative of the compositions of cast irons used, the following figures, resulting from the analysis of a large mould which had produced 130 ingots, are instructive:—Total carbon, 3.70 per cent.; graphite, 2.91; manganese, 0.42; silicon, 0.98; sulphur, 0.03; phosphorus, 0.026 per cent.

The macrostructure shown in Fig. 10 illustrates, in a general way, the change gradually taking place in the iron at the ingot surface. The type of iron used is invariably that which will cast "grey," and its actual analysis is frequently determined by the desirability of melting up the old moulds in the steel-making furnaces which they are serving. Hard or white cast iron is unsuitable, owing to its brittleness, and to its readiness to fracture under stresses resulting from unequal heating, which is a necessary condition of service.

The following values of the physical properties of iron employed for ingot moulds are stated for later use in regard to the general problem under consideration:—

p = specific gravity = 7.2.
s = specific heat = 0.125 cal. per grm.
k = thermal conductivity = 0.11 cal. per sq. cm. per deg. C. per cm.
h = co-efficient of radiation (according to Newton's law of cooling) = 9×10^{-4} cals. per deg. C. per sq. cm. (at 300 deg. C.).

Some of these data can well be amplified, especially as to their values at high temperatures.

Characteristics of Representative Moulds.—The moulds A, C, D, and F (Table I) are those used for producing the smaller alloy-steel ingots. They all have superimposed refractory-lined feeder-heads, the walls of the mould are suitably increased in thickness towards the bottom, and the cross-section of the ingot is greater at the top than at the bottom. At the position XX, half-way down the chill portion of the ingot, a square foot of the mould covers much less than its own weight of liquid steel, the percentage relationship of the weight of the mould to the steel being of the order of 133 to 204 per cent. This decreases upwards and increases downwards, thus ensuring that the freezing of the steel is less rapid as the mould is ascended. The moulds N, O, P, Q, and R are those used for the larger forging and alloy-steel ingots, and in general principles will be seen to conform with the smaller moulds just discussed. They all have refractory-lined feeder-heads, and are larger in internal section at the top than at the bottom. Although the walls of the mould do not increase in thickness down the chill, still in every case the local ratio of weight of mould to the quota of steel which it covers increases down the ingot owing to the decreasing sectional area of the ingot. At the position XX, the percentage weight of the mould to the steel in these larger ingots is of the order of 98 to 119 per cent.

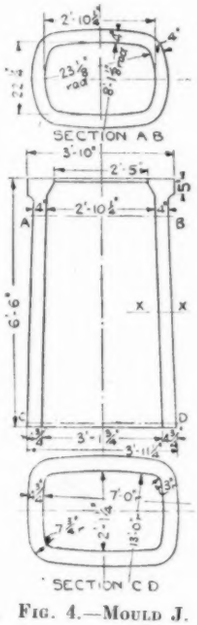


FIG. 4.—MOULD J.

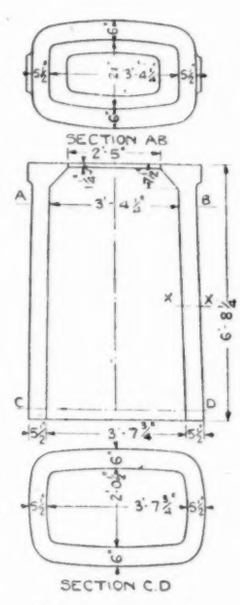


FIG. 5.—MOULD K.

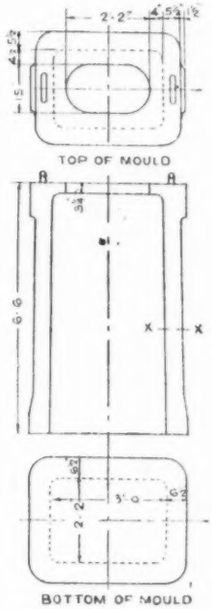


FIG. 6.—MOULD L.

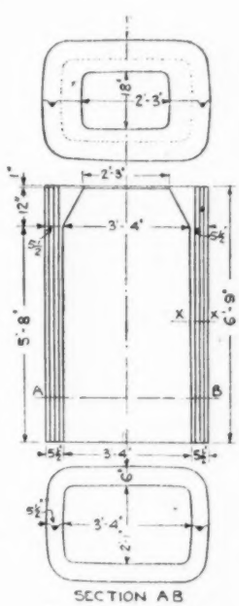


FIG. 7.—MOULD M.

	Mould J.	Mould K.	Mould L.	Mould M.
Weight of steel covered by 1 sq. ft. of mould at XX	Lbs. 301	Lbs. 312	Lbs. 287	Lbs. 303
Weight of mould per sq. ft. of surface of ingot at XX	206	258	277	258
Sectional area of ingot at AB	Sq. in. 688	Sq. in. 809	Sq. in. 808	Sq. in. 938
" " " at CD	896	1,018	924	—
" " mould at AB	446	704	731	818
" " " at CD	580	826	945	—
Total weight of ingot	Tons cwts. 6 15	Tons cwts. 7 15	Tons cwts. 7 14	Tons. 8
Weight of chill portion of ingot	6 15	7 15	7 14	—
" " " " mould	5 3	7 11	7 16	—

Moulds E, G, H, and I are used for carbon steels.

Moulds J, K, L, and M are of particular interest, being the moulds used in casting ingots from non-piping steel. No feeder-head is provided, and the ingots are usually heavier in section towards the bottom than towards the top. The mould walls are practically of uniform thickness and partially form a chill top. At the position XX the weight of mould covering its quota of steel is much less than that of the steel, the relationship being of the order of 68 to 85 per cent., which is considerably less than is the case with the other type of moulds, particularly the smaller sizes.

Mould B is included as an example of moulds used in large quantities years ago when ease of manipulation was placed before quality of product; the reason for discarding such a form of mould was not so well appreciated then as now.

Considerations in the Design of Moulds.—In the design of the shape of the mould five points concerning the ingot must be borne in mind:—(*a*) Freedom from cavity; (*b*) suitability for and ease of further working; (*c*) the stresses set up on cooling; (*d*) the elimination, if possible, of planes of weakness; and (*e*) the layout of the segregate. The freedom from cavity depends on the supply of sufficient molten material to fill up the spaces produced by contraction, and the prevention of isolated lakes of molten material. The former is controlled by the design of the feeder-head, and does not concern the mould itself. The latter is influenced by the relative rates of cooling of the various portions of the ingot, the change in dimensions on freezing, and the coefficients of expansion of both the solid and molten materials, and the design of the mould. Ingots with the narrow end at the top are most likely to produce these isolated lakes; ingots with the wide end at the top reduce this possibility. The correct taper is difficult to decide, as it depends on the rates of cooling at the freezing temperature in the various parts of the ingot. The taper should be such as to make possible efficient feeding of the body of the ingot.

Planes of Weakness in the Ingot.—Planes of weakness are caused where the crystals growing from two faces meet. They are bound to occur in those portions of the ingot where the freezing produces columnar crystals. Therefore, the closer the internal shape of the mould conforms to that of a cylinder, the less will be their effect. Circular ingots, especially in the larger sizes, however, are prone to stress cracks. Octagonal or hexagonal moulds have actually proved better for the larger ingots; except in the earliest stages, they freeze internally in very much the same way as they would in a cylindrical mould.

Stresses in the Ingot due to Cooling.—Owing to the difference in the rates of cooling of the outside and inside of the ingot, stresses are invariably set up in the cooling ingot, and they may be of such magnitude as to lead to cracks. These stresses increase with an increase in the temperature gradient across the section, and vary with different types of steel. The design of the mould, therefore, both in shape and dimensions, must be such as to reduce this temperature gradient as much as possible, bearing in mind the other features of the ingot. In this respect the position and magnitude of the change points, if any, in the steel are of importance. The lower the temperature at which they occur, and the greater their magnitude, the greater will be the stresses produced.

As regards the stresses and planes of weakness, as the ingot cools the outside tends to contract at a greater rate than the inside, at any rate during the earlier stages, while the temperature gradient is changing. Tensile stresses are therefore set up in the periphery, and may be sufficient to produce cracks there. Later on, when the outside has become comparatively cold and the inside is still cooling, the nature of the stresses is reversed. The tensile stresses are then present in the middle of the ingot. The magnitude of the stresses depends on the relative rates of cooling of the inside and outside of the ingot. A thick mould might therefore be expected to increase the stresses in the early stages, but later on it would cause a slower and more uniform rate of cooling throughout the ingot, which would tend to decrease the stresses. Stresses, too, are produced by the passage of various parts of an ingot through the critical ranges at different times. Many factors enter here, such as the temperature distribution and the influence of the rate of cooling on the actual temperatures of the transformations. These are determined by the chemical composition, which also influences the magnitude of the changes that occur along with them.

Necessary Empiricism in Design.—In order correctly to design an ingot mould, bearing in mind the factors enumerated above, one must first be satisfied as to the best rate of cooling and temperature gradient across the ingot, especially at the period when the material is at the point of freezing. It will naturally vary at various places in the ingot. Further, the best rate of cooling may be different for different steels. In other words, the design of the mould will depend on what is desired in the finished ingot. If an ingot be required in which the amount of columnar crystals is to be as large as possible, then the thicknesses of the walls should be adequate. Without knowing, however, the rates of cooling which give rise to the formation of the columnar crystals, the thickness of mould wall cannot be predicted. It would appear that the limiting depth of these crystals is already reached with

fairly thin walls, so that any increase in thickness of mould wall beyond this has very little effect. It has been suggested that the influence of varying thickness of mould may be divided into three stages; (1) The initial stage, in which there is the sudden drop in temperature at the outer surface of the ingot, due to the chilling action of the mould; (2) an intermediate condition, when the mould has become heated and there is a more or less gradual change in the temperature at the interface between ingot and mould; (3) the final stage, when the ingot and mould cool together, almost as if they had become one integral mass—that is to say, when the mould has practically lost its initial function as a receptacle of heat and become simply a conductor. The thickness of the mould will operate in different directions in the three stages, between which there is, of course, no sharp division. At the commencement of the first stage—that is, as soon as the liquid steel is poured into the mould—the outer skin of the ingot and the inner skin of the mould rapidly approach the same temperature. This temperature is independent of the thickness of the mould, and is determined mainly by the initial temperatures of the steel as cast and the mould.

Conclusion.—It appears that even if a complete mathematical expression could be given to represent the freezing of the ingot in the mould, there would still be considerable doubt as to how to apply it, until agreement is attained as to the best crystalline arrangement to aim for, and even then the influence of the rate of cooling, or of the velocity of freezing across the section, on that crystalline arrangement must be known. It is therefore clear that for the present the Committee can well leave the matter as one requiring much further elucidation, and simply present the data of the actual moulds concerned in the production of the ingots under discussion.

(To be continued.)

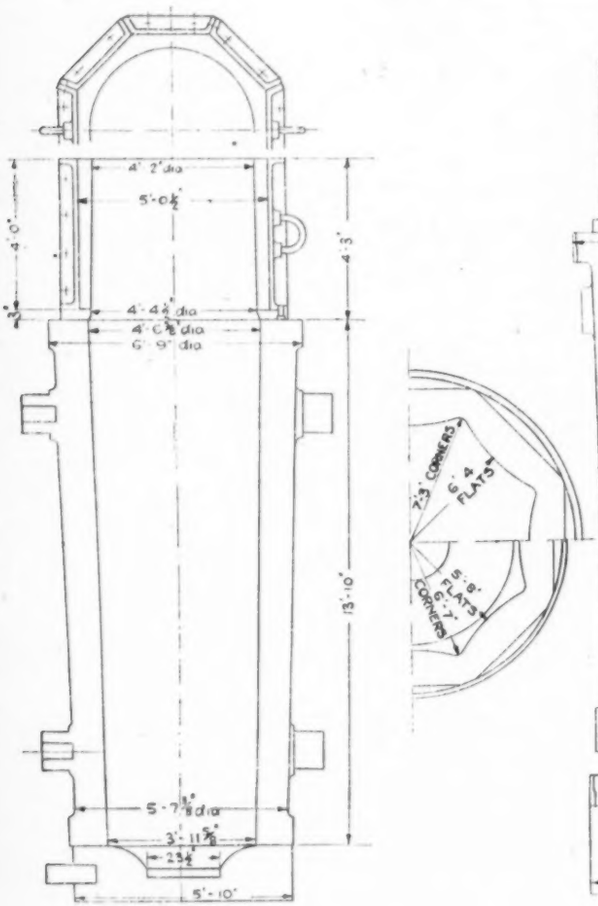


Fig. 8.—Mould Q.

	Tons.	Cwts.
Total weight of ingot	50	3
Weight of chill portion of ingot	40	8
Weight of chill portion of mould	41	4

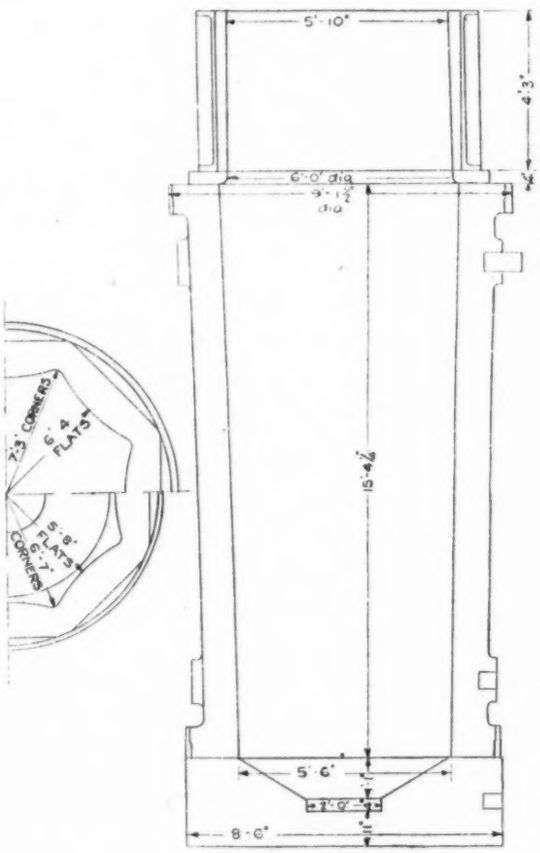


Fig. 9.—Mould R.

	Tons.	Cwts.
Total weight of ingot	119	10
Weight of chill portion of ingot	96	10
Weight of chill portion of mould	64	2

German Foundrymen to Meet in Danzig.

The Verein Deutscher Eisengiessereien, Giesserei Verband (the German Ironfoundry Employers Federation) has chosen Danzig as the venue for the annual meeting. It opens on June 14, when, during the evening, there will be an informal reception. At 10 a.m., on June 15 (Friday), the first session will be held, when the main committee on foundry practice will give a report on its activities. At 12 the question of scrap buying will be dealt with; whilst at 3 p.m. Herr Hemprich will read a Paper on the Danzig Shipbuilding Industry, followed by Prof. Dr. Heuser on the Present Situation of the Mechanisation of Agriculture and its Further Possible Development. Finally, Dr. Geilenkirchen, the editor of "Die Giesserei," will give an address on Current and Future Problems in Foundry Practice.

The Saturday morning is to be given over to an inspection of the Danzig shipyards, whilst the afternoon will be taken up by consideration of reports on the commercial position of German iron foundries, pig-iron markets, scrap markets, and the fuel market. In the evening there is to be an excursion by boat across the harbour to Zoppot, where a social gathering will be held in the Casino Hotel.

On Sunday morning Dr. Werner, the Chairman of the Association, is to give an address on its activities during the past year, followed by the general business meeting of the Association, the session concluding with a Paper by Prof. Dr. Leidig on the Influence of the East on German Economics.

On Monday the visitors are to go by steamer to Pillau, where they will visit the Palmickel amber factory, proceeding later to Königsberg. The last day, Tuesday, the conferences proceeds to Marienberg, where the Castle will be visited, and the closing banquet will be held. For those visitors who can remain with the party—a four-day post-conference tour has been arranged, covering several towns in East Prussia.

Inside Surface of Mould.

Fig. 10.—Macrostructure of Used Ingot Mould, showing Decarburisation of the Inner Surface extending to some Depth. (Full Size.)

Large Australian Steel Company.—A cable from Melbourne states that a company is in process of formation, with a share capital of £3,000,000, to take over the iron and steel works of the Hoskins Company, Limited, of Lithgow, and transfer them to Port Kembla. A part of the plant will probably be taken from existing works in this country. The Company is to acquire Dorman Long's fabricating and other Australian works, with the exception of the Sydney Harbour Bridge contract. The chief shareholders will be Hoskins, Dorman Long, Baldwins and Howard Smith, whose shipping and sales business will be at the Company's disposal.

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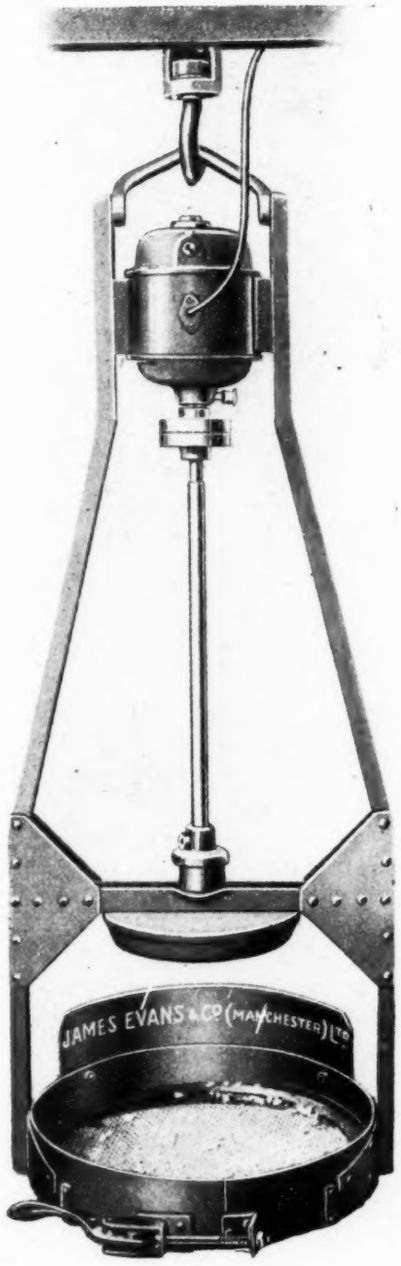

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An Improved Method for the Rapid Determination of Gases in Metals, Especially of the Oxygen in Steel.

By W. Hessenbruch and P. Oberhoffer.

In the "Foundry Trade Journal" of February 9, 1928, there was published an account of comparative determinations by different methods of gases in metals. A detailed account of the experiments of Prof. Oberhoffer and W. Hessenbruch, and of the method favoured by them, has now appeared in "Archiv für das Eisenhüttenwesen." Below are described the most important points investigated, and a short account given of the new method.

Processes for the estimation of the gaseous constituents of metals have in the course of years undergone many changes, as is only to be expected from the advances in knowledge of the underlying theory and in experimental technique.

A reliable and successful vacuum-fusion method for the determination of gases in metals must fulfil the following requirements: (1) Quantitative extraction of all gaseous elements; (2) exclusion in the highest possible degree of all disturbing secondary reactions; (3) high vacuum at temperatures of approximately 1,600 deg. C.; (4) maximum simplicity of necessary apparatus, and (5) minimum time per determination.

The authors commenced, three years ago, at the Iron and Steel Works' Institute attached to the Technical High School, Aachen, experiments having in view the development of processes hitherto in use in such a way as to bring them more into conformity with the requirements just outlined. It soon transpired that for the extraction of the whole of the gases, particularly of the oxygen, the temperature (1,200 deg. C.) hitherto employed did not suffice. With the usual furnaces, however, increasing the temperature caused the secondary reactions to assume such proportions that carrying out of the analysis was rendered impossible.

After extensive testing of various types the authors decided in favour of the high-frequency induction furnace, although choice of this type did not appear to fulfil requirement (4). Through the design of a suitable charging device it was found possible to run one analysis immediately after another without intermediate cooling of the furnace. In this way, the time required per analysis was greatly reduced.

The experiments for finding the necessary temperature showed that a part of the oxides present in steel require a temperature of 1,500 to 1,600 deg. C. for conversion into carbon monoxide. At this temperature the maximum quantity of oxygen is apparently obtained. The experiments at temperatures above 1,600 deg. await further confirmation. Although hydrogen and nitrogen can be extracted from the liquid metal at far lower temperatures than the oxygen, higher temperatures appear to yield, in the case of these elements also, greater quantities of gas. In any case, the time required for de-gasification is much reduced by increase of temperature.

Investigations of the influence of secondary reactions showed that the presence of metals, the heat of formation of whose oxides exceeds that of ferrous oxide, leads to errors in the estimation of oxygen unless an extraordinarily high vacuum can be attained. Such a vacuum cannot, unfortunately, be achieved when boats made from refractory oxides are employed as reaction vessels, for the reduction of the oxides in the steel ceases when the oxygen pressure corresponds to that of the refractory material. The amount of the oxides remaining unreduced is proportional to the oxygen concentration. In the cases of manganese and of aluminium this prejudicial influence to which the old vacuum-fusion process is liable was demonstrated by the authors in their experiments. The new process is claimed not to be susceptible to this source of error owing to the far higher vacuum employed.

Experiments regarding the formation of water in the vacuum-fusion process demonstrated that water formation only occurred to an appreciable extent at temperatures below 1,000 deg. C., and that the weights of water found are almost entirely to be traced to the absorption of moisture. With high sulphur-contents, hydrogen sulphide and carbon disulphide are formed in detectable quantities. In all cases investigated the sulphur content of the gas mixture drawn off from the sample was considerably less than the loss of sulphur sustained by the melt. The major portion of the sulphur-containing gases are decomposed again before leaving the furnace. With 0.050 per cent. S and a temperature of 1,400 deg. C. the error is 0.003 per cent. O. At higher temperatures and with lower sulphur contents this error is reduced.

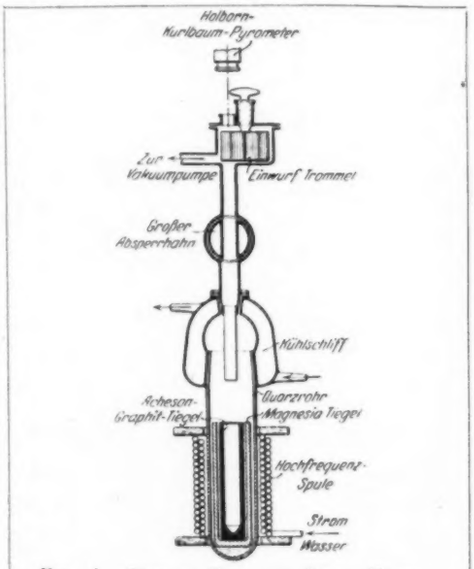

Fig. 1.—Section Through 3-kw. High-Frequency Melting Furnace Employed showing Charging Device.

Holborn-Kurlbaum-Pyrometer=Pyrometer.
Zur Vakuumpumpe=To Vacuum Pump.
Einwurf-Trommel=Charging Drum.
Grosser-Absperrhahn=Large Stop Cooler.
Kühlschliff=Cooling Jacket.
Quarzrohr=Quartz Tube.
Magnesia Tiegel=Magnesia Crucible.
Hochfrequenz-Spule=High-frequency Induction Coil.
Acheson-Graphit-Tiegel=Graphite Crucible.
Strom Wasser=Water-cooled Conductor.

Further tests made for the purpose of studying the reduction of various materials for the boat (or crucible) at various temperatures showed that above 1,200 deg. C. all refractory oxides are strongly reduced and their utilisation for higher temperatures is out of the question. The sole material which can be used for crucibles is graphite. The graphite crucible must, however, be first de-gasified and then kept out of contact with the air.

Upon the basis of the preliminary experiments briefly outlined above, an apparatus was designed incorporating the furnace arrangement shown in the illustration. A quartz tube serves as the vacuum vessel and is located inside a coil through which is passed an alternating current of 8,000 Hertz. Within the quartz tube is the graphite crucible, surrounded by an insulating tube, or rather secondary crucible, of magnesia. The crucible is heated by high-frequency induction and de-gasified by an oil-immersed vacuum pump and a mercury vapour diffusion pump. Thereupon a dripping pump is connected in place of the oil-immersed pump in series with the diffusion pump and the test-piece—which is already under vacuum—is dropped by means of the special charging-device into the hot crucible.

The test-piece melts and the gases given off are immediately removed by the diffusion pump from the furnace to avoid secondary reactions of the gases with the metal fittings of the latter. The gases collected by the dropping pump were subjected to a quantitative analysis for carbon dioxide, carbon monoxide, hydrogen and nitrogen.

Tests with pure oxides indicated that the reduction at 1,400 to 1,500 deg. C. amounted in as little as 20 mins. to 70 per cent. and more and that at 1,500 to 1,600 deg. reduction should be complete. It was ascertained that the surface area of the test-piece per unit of weight had a decided significance. Tests with drillings are thus inadmissible and the sample must be in the form of a single piece of metal.

The duration of a gas analysis for oxygen, hydrogen and nitrogen amounts to about 30 to 45 mins. The de-gasification of the crucible takes 3 to 4 hours, but then a series of 10 to 15 analyses can be run in rapid succession. The method is applicable also to non-ferrous metals, suitable provision being made to deal with the gases to be encountered. To the authors' Paper there is appended a list of 147 references to the literature.

Reports and Dividends.

John I. Thornycroft & Company, Limited.—Interim dividend of 3 per cent. on cumulative preference shares.

Glenfield & Kennedy, Limited.—Final dividend on the ordinary, 6 per cent., actual, making 10 per cent. for the year.

Siemens Brothers & Company, Limited.—Final dividend, 5 per cent., making 7½ per cent., less tax, on the ordinary shares for the year.

Allen-Liversidge, Limited.—Preference dividend at the rate of 6½ per cent. per annum, less tax, for the six months ended April 30, 1928.

Palmers Shipbuilding and Iron Company, Limited.—Profit, £10,490, after providing for interest on first mortgage debenture stock. This is an improvement on the results of the five previous years.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Profit for past year, £388,667 (against £140,583 for 1926). From this has been deducted provision for certain contingencies of £250,000, while interest charges amount to £666,620, leaving a net loss for the year of £527,953 before providing for depreciation. Allowing for the credit balance of £114,181 brought forward, there is a debit balance as at December 31 last of £413,771. This has been deducted from the general reserve, reducing it to £86,228.

Sir William Arrol & Company, Limited.—Profit, £54,095; dividend on preference shares for half-year ended December 31, 1927, less tax, absorbed £12,040; special reserve, £21,027; carried forward, £21,027. Directors consider that, having regard to general condition of trade in the country, results are satisfactory. Prospects for the current year are not less favourable. Amount at debit on deficiency account has been written off ordinary share capital, and arrangements have been made with company's bankers for the financial accommodation referred to in the scheme sanctioned by the Court in February, 1928. Arrangements are being completed to grant to company's bankers a bond in security over heritable assets to cover advances up to £200,000. At present the advances from the bank are well under that sum. The Board has been strengthened by the appointment of Sir Daniel Neylan as a director.

Personal.

Mr. R. A. Morrison has been elected a director of Stewarts & Lloyds, Limited.

Mr. T. L. Taylor (Chairman and Managing Director of Taylor Bros. & Company) and Mr. A. Spencer (Chairman of Spencer, Moulton & Company) have been appointed Chairman and Vice-Chairman respectively of the Board of Metropolitan Carriage, Wagon and Finance Company.

Wills.

Colquhoun, J. P., of Swansea, South Wales, representative of T. W. Ward, Limited, of Sheffield £1,810

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Foundry Layout.

Following the annual meeting of the Middlesbrough Branch of the Institute of British Foundrymen, Mr. W. E. Styles, of Messrs. R. W. Crosthwaite, Limited, of Thornaby-on-Tees, gave an address on the "Advantages of Studying Layout," in the course of which he said the many difficulties they encountered in modern foundry practice behoved a man to take a pride and interest in his work. He knew from his own experience that the slap-dash methods that were employed 20 years ago would not be of much use to-day, especially when making intricate castings for the motor and electrical trades. Once upon a time if a casting came within a quarter-of-an-inch of what was wanted it would be passed, but now he often got complaints if a casting was $\frac{1}{32}$-in. different from the drawing. He thought there was a need for more modern methods in the making of delicate castings. If they were to take a census of all the foundries in the country they would find about 80 per cent. of them making castings in exactly the same manner as they were done 100 years or more ago. Under circumstances of that sort could they expect to make progress? The men of to-day were in the main better educated, and therefore in a better position to grasp new ideas much quicker than their grandfathers. He wanted to see greater interest created in the foundry trade, and the adoption of new methods. Much could be done in studying the layout of a job, not only to make it more interesting, but to cheapen the cost of production without paying low wages. One man excelled in one class of work and another in another class, and he thought managements should study the layout of their jobs in such a manner to suit the capabilities of workmen.

He had often noticed that different districts contained men of different calibre. It was unaccountable, but nevertheless true. In the Midlands he had noticed that core-makers were exceptionally good, moulders just ordinary. In the South it was just the reverse. It must be obvious that in the Midland area a job should be so designed to suit the core-maker as much as possible to get the job made at a reasonable cost; while in the South it was the reverse. In regard to castings for motor cylinders and parts, this was very noticeable. Patterns made in the Midlands were designed to simplify the moulding as much as possible, putting parts in cores if it could be managed at all. If this same pattern was sent to a motor-cylinder foundry in the South, where would they be? The foundry manager, knowing the capabilities of his various departments, would say immediately that he could not produce the casting at a competitive price. He would want to make a new pattern, this time making an elaborate pattern and simplifying the core-boxes.

How Different Parting Increased Production.

In a motor-cylinder job, his firm parted their pattern in an entirely different manner from one sent by the customer, with the result that it was now possible to give one part of the pattern to one gang, thereby enabling the firm to make 60 per day. They also made the core-boxes very simple, and instead of core-makers dressing and blacking their own cores they let the core-makers make cores only. The outcome of this was that they got a much larger quantity of cores made per day. They then set up another department known as a core-dressing department.

Continuing, Mr. Styles said: This department takes the dried cores and dress and black them, and furthermore assemble all these cores on their bench. This procedure simplifies the coring up to a very great extent. The man responsible for coring up is the same man that cored up under the old method, then he had to put in every core separately, with the result mentioned before, that is 5 to 6 per day. Now that the cores are assembled in one block the moulder has only to drop this block of cores in his mould plus one or two odd cores and it is possible for this one man and his lad to core up and get ready for casting at least 60 four-bore motor cylinder blocks per day.

Co-operative Effort Needed.

Although essentially the author deals personally with castings for the motor trade, he feels convinced that the same remarks apply to dozens of other castings. What it seems desirable to emphasise is the necessity of studying the blueprints, for any job, for some considerable time and try to get down, not altogether to the simplest way of making the job, but rather to a way of making that will most nearly suit the capabilities of the various departments. Probably what is needed in this country is an advisory centre of some sort. We hear of consulting engineers, etc., why not consulting foundrymen? A centre of this sort could be set up in any large district, such as Middlesbrough. It could be maintained by a yearly subscription from a number of firms in the district, then one or two experts in foundry matters could be engaged to advise in all the little difficulties that arise. Then there is another way, supposing every month all the members met together and any job that was giving considerable trouble in any foundry could be discussed. The old saying that two heads are better than one applies very forcibly in foundry matters. No one looks down upon a manager or foreman in a works because he has trouble, all experience it sometime, and if a foreman or manager could only meet several men in similar capacities each month, and air his troubles, it probably would be found that there were others who had had a similar difficulty and were in a position to advise what to do to put the matter right. Then again, whatever class of work one is accustomed to, there often crops up a job of a totally different nature. If one is confident that one can make a success of it, then go ahead; but if, on the other hand, there are doubts about it, it is best to acknowledge it. It is preferable therefore to bring along the drawings or a description of the job and let us all get down to it and try to simplify it as much as possible.

Where Many Foremen Fail.

There exist many exceptionally good foremen, who can run a shop most efficiently when they have a set of patterns and core-boxes handed to them to get away with. But if the same men were confronted with a blue-print they have not the least idea of what they are looking at. Is it fair to the employer for the man to make believe he knows what he is looking at and perhaps land both himself and his employer into trouble by under-quoting for the job? It is nothing against the man that he cannot read the drawing, and managements do not expect to get men that can do everything, and they should only be sadly disappointed if they did. If employers were members of this suggested advisory centre they could bring along any drawing and get expert advice as to what it would mean to make the job.

Looking at the other side of the question it is found that where the manager has had no real practical experience in running a foundry, he has other qualifications which assign him to the position he holds. Here he may understand a drawing fully, but when it comes to deciding what price each worker requires to make each different part he is somewhat lost and has to consult his foreman for the information he requires. If a works contain this combination of manager and foreman, no doubt they can get along satisfactorily, but if not, then the matter could be put before the members and what the job was worth to make could soon be arrived at.

Increased Number of Works Visits Desirable.

Another thing which would be most helpful is to extend the facilities for visiting different foundries to enable men to improve their knowledge. These visits are arranged by the I.B.F., but are members getting enough of them? Most employers would be willing to let members visit their shops and also would be willing to give at least one of their staff the opportunity of spending a half-day now and again in another foundry to see the different methods employed. The benefits derived from these visits would be extended to both the employers and their staffs.

One of the essentials to progress is co-operation between the various departments. It is useless trying to progress if, say, the designer is pulling in an opposite direction to the rest of the works. In many shops the pattern shop is left entirely to itself, then when the pattern eventually arrives in the foundry there is only one way in which the job can be made. The pattern shop must come into line with the foundry to obtain the best results. Nowadays there is too much attention paid to making an engine look pretty, and insufficient to designing it to suit the foundry. Once one can get the designer and pattern shop to fall into line with you the rest should be fairly simple. All jobs must be studied from every angle; eliminating all the unnecessary work, avoiding loose pieces wherever possible, and in particular paying close attention to the sand. The main advantages derived in studying the layout of the job are a large saving in the cost of production, an improved output, and a smoothly-running shop. The saving of cost of production is ensured, because every available hand is being used to its utmost ability. The improved output is maintained in much the same manner. Each individual is engaged on that part of the job whereby he can produce the maximum amount of work in the minimum of time. Thirdly, the sweet running shop is ensured by each worker doing his or her part without having to hesitate as to their ability to do themselves justice. By applying these platitudes instances are available where castings are being produced at about 75 per cent. of the original cost solely through making the job in an up-to-date manner, unassociated with the paying of low wages.

Increased Production Increases Wages.

Referring to the case of a man coring up sixty cylinders per day, when the job was made from the old pattern and by an old process, we could not pay more than two-and-six each for coring up, thereby enabling that man to earn fifteen shillings per day. When the job was brought up-to-date and the man was able to core up sixty per day, although his price dropped to sixpence each, he was able to earn thirty shillings per day instead of fifteen. This is an exceptional case, but more or less all the jobs show a great saving in production costs without in any way reducing the earnings of the worker; in fact, in 90 per cent. of the cases their earnings are increased, besides the job being made much simpler for them to handle.

In reply to a question by Mr. Walker, the lecturer said he used local sand among others. In some of the very delicate cores, however, they could not get local sand to stand up.

MR. TOY asked if a difference in the quality of castings was found when increased production was obtained, and Mr. Styles replied that there was a difference. The quality improved and the castings they were making were in advance of anything they had previously done.

In reply to MR. RIDSDALE regarding the kind of iron used by Messrs. Crosthwaite, Mr. Styles said they had tried several kinds of iron but the material they were now using was entirely local.

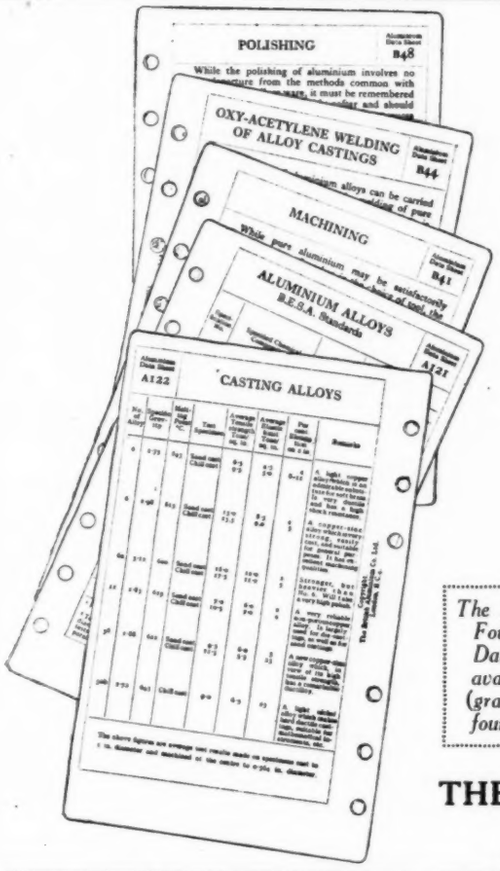
Proposing a vote of thanks, MR. F. P. WILSON said Mr. Styles' address was crammed with interest, apart from practical details. The lesson it taught was the importance of co-operation in the works generally. It was essential that if they were to obtain the best results that there should be co-ordination between departments.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for March, report that the production of pig-iron in March amounted to 592,600 tons, compared with 550,800 tons in February, the daily rate being 19,116 tons, compared with 18,993 tons respectively. Two more furnaces were in blast at the end of the month than at the beginning: two having ceased working and four having been blown in. The production of steel in March amounted to 793,300 tons, compared with 764,400 tons in February, and was the highest since May last year, when the output amounted to 884,600 tons.

XUM

F.T.J. 19.5.28



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SULPHUR	,, ,,	0·8%
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MOISTURE	under	1·50%

Trade Talk.

Some of the Papers to be read at the annual conference of the Institute of Quarrying at Blackpool on June 4 and 9 indicate close contact between the Universities and industry. For example: Professor P. G. H. Boswell, of Liverpool University, will deal with "Silica—its Commercial Properties and Markets," and Mr. W. J. Rees, B.Sc., of Sheffield University, will lecture on "Commercial Sands."

Messrs. Bolckow, Vaughan & Company, Limited, of Middlesbrough, and Crittall's became co-partners some time ago in a new company which has been formed to operate the Darlington Rolling Mills at Rise Carr. It is now stated to be the intention to erect a new small mill to roll sections used in the construction of steel window frames. Messrs. Crittall's have, it is understood, hitherto bought the bulk of their requirements from the Continent.

A circular to the shareholders of J. H. Andrew & Company, steel manufacturers, Sheffield, states that the directors have asked Mr. Donald F. Sutherland, of Lindsay, Jamieson & Haldane, to reconstruct the company and reorganise its finances, and for this purpose Mr. Sutherland has been appointed receiver for the debenture holders. Messrs. Andrew are largely interested in the works of Messrs. John Perks & Sons, Limited, at Wolverhampton, large makers of edge tools.

A loan of £3,000,000 has been raised in London this week for the railway electrification and erection of a power station in Hungary. Contracts have been placed with the English Electric Company, Limited, Babcock & Wilcox, Limited, and sub-contracts for transmission lines with Callenders Cable and Construction Company, Limited, and a foreign firm. The English orders will probably amount to over £1,000,000. Part of the money is being found by a loan guaranteed by the British Government under the Trades Facilities Act. This is the last industrial loan to be so guaranteed, the Act having expired.

The Department of Overseas Trade inform us that memoranda giving particulars of the proposed programme of public works relative to railway construction, port works construction, and building construction in Chile, for execution during the years 1928 to 1933, have been received from the Commercial Secretary at Santiago (Mr. W. F. Vaughan Scott). Firms in a position to offer British materials likely to be required can obtain further particulars on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference A.X. 6270.)

A company has been formed to acquire exclusive licenses for Dr. Ruth's inventions, covering his accumulator system. The Ruth accumulator is for use in connection with power plants where there is a varying load and where the demands for steam are of considerable magnitude. German and Swedish engineers have so far recognised the merits of this device that they have been installing these accumulators for several years past with excellent results. Recently, the largest electric light plant in Germany, now being built in Berlin, has adopted the device, and is installing 24 accumulators in an extensive scheme for providing electric power.

Messrs. Dunford & Elliott (Sheffield), Limited, manufacturers of hollow steel bars, inform us that they have devised a new and improved method for producing these by means of metal cores which render the available diameter of hole in relation to outside diameter of the bar much greater than with the sand-core process, a hole 25 per cent. of the cross-sectional area of the intended bar now being a commercial possibility. Greater consistency in accuracy of shape, straightness and concentricity of the holes, in hollow steel bars is claimed to result from the adoption of the new process, and furthermore, the new process may be applied to any class of steel.

The Standing Committee appointed by the Board of Trade opened their inquiry on May 7, under the Merchandise Marks Act into the application by the Sheffield Cutlery Manufacturers' Association for an order that all imported cutlery should be marked with an indication of origin. The applicaion was supported by the Ironmongers' Federation, and opposed by the London Chamber of Commerce. The applicants asked the Committee to pay particular attention to the aggravated danger of deception in the case of cutlery by marking articles with a description showing that they were not of English manufacture. They were asking for the protection of the reputation of Sheffield manufacturers and of the public, so that no longer would it be possible for a knife or pair of scissors to be sold marked, "Best steel" or "Warranted steel" when the article was made in Germany of steel which might not be of the kind referred to.

The Barrow Hematite Steel Company, Limited, has decided to abandon, for the time being, their Anticross iron-ore mine, at Dalton-in-Furness, owing to the high cost of pumping the excessive amount of water in the workings.

A communication from the Home Office refers to the draft Regulations proposed to be made under Section 79 of the Factory and Workshop Act, 1901, for factories in which horizontal milling machines are used. These draft Regulations were issued in April, 1927. Various objections were received, and in order to reach agreement it was arranged to discuss the points at issue with the Engineering and Allied Employers' National Federation and with the Railway Companies. The negotiations have been somewhat protracted, but the Secretary of State is glad to say that they have now been successfully concluded, and the revised draft has been issued. It provides that if the Chief Inspector of Factories is satisfied in respect of any class of horizontal milling machine or of any class of milling cutter used on such machines that, owing to the special conditions of work or otherwise, any of the requirements of the Regulations can be suspended or relaxed without danger to the persons employed, he may by certificate in writing authorise such suspension or relaxation for such period and under such conditions as he may think fit. Any such certificate may be revoked by the Chief Inspector at any time.

The annual dinner of the Institution of Mining and Metallurgy took place in London on May 8. Mr. Robert E. Palmer, the president of the Institution, presided. Sir Francis G. Ogilvie, the chairman of the Geological Survey Board, proposed the toast of "The Institution of Mining and Metallurgy," and said that, year after year, his knowledge and appreciation of the work of the Institution had grown, and he realised, as he was sure others did, the great value that it was to science. The most important part of the work of the Institution was to bring "the brotherhood of industry and the sisterhood of science into proper relationship." Mr. R. E. Palmer, in reply, said they all knew the aims and objects of the Institution, and to-day they could see the results. Some twenty-four or twenty-five years ago the condition of the Institution was far different from what it was to-day, and it would go on and progress. He would refer to the work of the Institution at the annual general meeting to be held before long. He spoke especially of progress resulting from the Congress in Canada, which had proved of great service. It had drawn attention to not only the mineral resources of Canada, but of the Empire and the world.

Contracts Open.

Barnstaple, May 24.—7,000 yds. of iron pipes, for the Rural District Council. Mr. J. C. Southcombe, Cross Street, Barnstaple. (Fee £2 2s., returnable.)

Cairo, June 3.—Supply and erection of a mechanical filter, two low-pressure and two high-pressure centrifugal pumps, one semi-rotary double-piston hand pump, also suction and delivery piping, a 10-h.p. electric motor, sterilising apparatus, etc., for the Egyptian Ministry of the Interior. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Reference A.X. 6,274.)

Cairo, June 30.—A weighbridge, platform weighing machines, counter balances, and Beranger balances, for the Physical Department, Ministry of Public Works, Cairo. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Reference B.X. 4,424.)

Johannesburg, June 21.—Supply, erection, etc., of one 20-ton road weighbridge, with platform 18 ft. by 8 ft., for the Town Council of Johannesburg. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Reference A.X. 6,269.)

Leeds, May 19.—Cast-iron pipes, wrought-iron tubes and fittings, iron castings, merchant iron and mild steel, bolts and nuts, washers, gas and pipe hooks, tinplates, black and galvanised iron, etc., for twelve months, for the Gas Committee of the Leeds Gas Department. Mr. C. S. Shapley, engineer and general manager, Gas Offices, Market Hall, Leeds.

Manizales.—Water meters, for the Municipality of Manizales. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Reference A.X. 6,234.)

Melbourne, June 20.—(1) One 7-ton steam-operated travelling crane and grab, or (1A) one 7-ton oil-operated travelling crane and grab; (2) one 5-ton steam-operated shunting crane, or (2A) one 5-ton oil-operated shunting crane, for the Victoria Government Railways Commissioners. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Reference A.X. 6,230.)

Ruislip, June 1.—Pumping machinery, etc., for the Ruislip-Northwood Urban District Council. Messrs. H. Humphreys & Sons, 28, Victoria Street, Westminster, S.W.1. (Fee £3 3s., returnable.)

Properties of Nickel Steels, with Special Reference to the Influence of Manganese.*

By J. A. Jones, M.Sc. (Woolwich).

(*Summary.*)

This is a voluminous and elaborate Paper of 36 pages, packed with tabulated and plotted results giving chemical analyses of the 43 steels tested, and recording the effects of nickel, carbon and manganese on (*a*) the critical ranges, (*b*) hardness after different rates of cooling, (*c*) mechanical properties (including the effects of low and high tempering temperatures), (*d*) the hardness of different sections quenched in oil.

In the author's summary of his conclusions he states that the properties of nickel steels containing carbon 0.2 to 0.55 per cent. and nickel 3 to 12 per cent. have been examined, with special reference to the effect of manganese.

(1) The critical ranges of these steels have been determined. Ac_1 is lowered by about 10 deg. C. for each 1 per cent. of nickel. In nickel steels with 3 to 5 per cent. of nickel, cooled at a rate of 4 deg. C. per minute, the Ar_1 point is lowered by an amount varying with the manganese and carbon content from 25 to 30 deg. C. for each 1 per cent. of nickel.

(2) In nickel steels with low manganese contents there is no advantage in increasing the nickel beyond 6 per cent., on account of the limitation imposed on the tempering temperature by the lowering of Ac_1. For a similar reason with higher manganese (0.8 per cent.) no advantage is gained by exceeding 4.5 per cent. of nickel.

(3) The effect of manganese up to 0.8 per cent. on the critical ranges of nickel steel is small. An increase of manganese from 0.4 to 0.8 per cent. in steels with about 4 per cent. of nickel causes a fall in Ac_1 of 3 deg. C., and a similar fall in Ar_1 when the rate of cooling is about 4 deg. C. per minute.

Chromium produces a decided rise in Ac_1 even when present in small quantities; 0.22 per cent. of chromium raises Ac_1 by 7 deg. C., though it has little effect on Ac_3, Ar_3 or Ar_1.

(4) The effect of manganese in maintaining increased hardness of 3 to 4 per cent. nickel steel at slow rates of cooling becomes most evident when 0.5 per cent. of manganese is exceeded. When both manganese and chromium are present the influence of the chromium in this respect is nearly twice as great as that of manganese.

(5) An increase of manganese in 3 to 4 per cent. nickel steels leads to an improvement in the elastic limit and yield point without loss of ductility. A sudden marked improvement becomes evident at a manganese content which is greater the larger the section treated.

(6) A nickel steel which, on account of its section, has received inadequate hardening may, after tempering, show the desired hardness and tensile strength; but when it is compared with a steel which has been efficiently hardened and subsequently tempered to give the same tensile strength, the mass effect will still be evident in lower elastic limit, yield ratio, elongation, reduction of area, and impact figures. These effects are due structurally to the separation of ferrite during hardening, and to the incomplete suppression of the pearlite change.

(7) Manganese has a marked influence on the mass effect in 3 to 4 per cent. nickel steel. A low-manganese steel will not harden satisfactorily even in very small sections. The amount of manganese necessary to secure adequate hardening varies with the size of section treated, but in no case should it be less than 0.5 per cent. A manganese content of 0.8 per cent. is an advantage in securing good tensile properties in large masses, and is preferable to an increase in carbon content above 0.4 per cent. On the other hand, a very high manganese content involves susceptibility to temper-brittleness, which has to be guarded against in heat treatment.

* Communication from the Research Department, Woolwich, read before the Annual Meeting of the Iron and Steel Institute.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—With the almost complete elimination of the speculative element in the Cleveland iron market, business is now chiefly confined to actual sales on consumptive account, and a dead level of prices which offer little inducement to forward buyers. It is, at least, satisfactory to note that Tees-side makers are now relieved of excessive accumulations in stock, and that furnace outputs are fully absorbed by consumers on current contracts. As a matter of fact, buyers cannot be induced to place forward contracts. If there were any indications of a rise in prices, they would be keen enough to do so, but everything points to a stabilisation of values at current levels, and that being the prevailing opinion, consumers see no reason to tie themselves down to contracts for delivery beyond the end of June. The outlook on the export side at the moment is mainly dependent upon the turn of events in the present Continental labour crisis, but last month's shipments from the Tees were disappointing, and there is considerable leeway to be made up before normal overseas trade is re-established. Meantime, prices remain firmly as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

Owing largely to the increasing use of basic and even forge iron for steel-making, there is a permanent contraction in the demand for hematite, and although there is a little foreign inquiry, buyers usually stipulate for a special analysis. For any orders for ordinary East Coast mixed numbers there is keen competition, and whilst 70s. is quoted for special brands, 69s. is still freely accepted, and No. 1 quality only commands a premium of 6d. per ton. On the North-West Coast Bessemer mixed numbers are still quoted at 70s. per ton at works.

LANCASHIRE.—Consumers of foundry pig in this area are reported to be buying on a slightly improved scale, but market conditions generally remain inactive as regards forward buying, notwithstanding price concessions on the part of makers. Current quotations rule about as follow:—Derbyshire No. 3 foundry, 71s. 6d. per ton; Staffordshire, equal quality, 71s. 6d.; with Cleveland at 79s. and Scottish at 87s. 6d. respectively, all delivered consumers' works.

THE MIDLANDS.—Black Country ironfounders, particularly those in the light trades, are still complaining of the paucity of orders, and under the present conditions do not feel disposed to buy more pig-iron than will cover their immediate wants. Small transactions are, therefore, a feature of the market at present. Prices are without change, No. 3 Derbyshire being quoted at 63s. 6d. to 64s.; Northants, 58s. to 59s.; North Staffordshire, 63s. to 63s. 6d., all f.o.t. at furnaces, with Lincolnshire at 72s. 6d. and Scotch brands at about 90s. per ton, both delivered at works.

SCOTLAND.—Business in the markets for Scotch foundry pig is extremely quiet, and smelters are having difficulty in getting rid of their iron. No buying of any large-sized tonnage is being made. The price remains unchanged on the basis of 70s. for No. 3 Scotch foundry at the furnaces.

Finished Iron.

The volume of business transacted in this class of material continues on a contracted scale, most of the Black Country mills being very short of work, as it is difficult to secure sufficient orders to keep their plants in regular operation. The price for crown quality bars continues to vary considerably. From Lancashire and other areas they can be purchased at £9, but the local price is between £9 5s. and £10. Nut and bolt iron is offered from £8 15s. to £9 5s. The Darlaston works, however, receive little support for irons of this nature, because of the Continental competition. There is still a big disparity between the prices for Staffordshire and imported material. Continental No. 3 iron is offered at £6 5s. per ton delivered, and the great proportion of business which is being placed must of necessity go abroad. The makers of Staffordshire marked bars continue fairly well occupied. The lower basis of £12 at makers' works has had some effect, but not to the extent the makers had hoped.

Steel.

The slightly better demand for steel and semi-products recently noted in the principal markets is maintained and encouraged by the advance in Continental prices, which have improved to the extent of from 2s. or 3s. in the case of some descriptions. This is largely due to buying in Continental home markets; but at the same time there has been a fair amount of export business transacted. This upward movement should assist the British makers by diverting some business in their direction. At Sheffield the call for acid steel billets of Siemens quality is on a fair scale, but output of basic quality is smaller, as a result of the lower demand, the prices ruling being:—Soft, £6 5s.; semi-hard, £7; medium, £7 2s. 6d.; hard, £7 12s. 6d. per ton, delivered. Steel hoops are moderately active at £9 10s. to £10 per ton. In the tinplate market a fair volume of business has been done, and most works, having good order books, are asking higher prices, more especially for early delivery. Prices of tinplates, I.C., 20 by 14 by 112 sheets, are quoted at 18s. 6d. per box.

Scrap.

Conditions in the various markets for foundry scrap metals continue fairly steady on the whole, and in the Midlands there is a moderately active demand for cast-iron scrap of all qualities. For heavy machinery cast-iron scrap, broken into cupola sizes, 67s. 6d. per ton delivered is asked, and 55s. per ton delivered for light cast-iron scrap. There is also a good demand for cast-iron borings at 55s. per ton delivered. In Scotland machinery cast iron is only in moderate demand, the price for cupola material ruling about 69s. 6d. to 70s., with heavy ordinary cast scrap at 5s. per ton less. Old cast-iron railway chairs are on offer at 68s. 6d. per ton, and light cast-iron scrap at 58s. 6d. to 60s. per ton, all delivered f.o.t. at consumers' works.

Metals.

Copper.—Only slight fluctuations in values have been recently marked in warrant copper, with a tendency upwards toward the week's closing market. The price of electro both here and on the Continent has remained practically stationary, while in America no alteration has been made in the figures recently quoted by the Copper Exporters Incorporated. A fair tonnage has been sold of late both here and on the Continent, but the rate of consumption in Europe fails to improve to the required extent.

Closing quotations are:—

Cash.—Thursday, £61 13s. 9d. to £61 15s.; Friday, £61 15s. to £61 16s. 3d.; Monday, £62 5s. to £62 6s. 3d.; Tuesday, £62 10s. to £62 12s. 6d.; Wednesday, £62 11s. 3d. to £62 12s. 6d.

Three Months.—Thursday, £61 18s. 9d. to £62; Friday, £62 to £62 2s. 6d.; Monday, £62 8s. 9d. to £62 10s.; Tuesday, £62 15s. to £62 16s. 3d. Wednesday, £62 16s. 3d. to £62 17s. 6d.

Tin.—Though inclined at times to unsteadiness, the position in standard cash tin may be regarded as fairly satisfactory from a market point of view. The American tinplate trade continues active with favourable reports coming from the canning section. Welsh consumers have been purchasers of English tin recently, and in view of the fact that South Wales is well booked up with tinplate orders, a certain amount of optimism may be shown on the market by sellers who have hopes of bringing off further sales in this direction.

Official closing prices:—

Cash.—Thursday, £234 5s. to £234 7s. 6d.; Friday, £232 7s. 6d. to £232 10s.; Monday, £232 5s. to £232 7s. 6d.; Tuesday, £232 15s. to £232 17s. 6d.; Wednesday, £232 to £232 2s. 6d.

Three Months. — Thursday, £233 10s. to £233 12s. 6d.; Friday, £231 15s. to £232; Monday, £231 12s. 6d. to £231 15s.; Tuesday, £232 to £232 2s. 6d.; Wednesday, £231 7s. 6d. to £231 10s.

Spelter.—Movements in ordinary spelter at the moment are largely influenced by the reports concerning the progress of the negotiations for establishing a world cartel of zinc producers. In the course of an international meeting of zinc producers in Brussels recently a resolution was unanimously adopted in favour of controlling the market by the creation of a bureau of statistics and by the restriction of production if it should be necessary. It was further stated that oversea producers are to be invited to co-operate in the European convention.

Official close:—

Ordinary.—Thursday, £26 5s.; Friday, £26 6s. 3d.; Monday, £26 5s.; Tuesday, £26 6s. 3d.; Wednesday, £26 5s.

Lead.—Developments of any special importance have been absent from this market recently. The amount of soft foreign pig on offer is apparently in excess of current requirements, although the opinion is expressed that inquiries for supplies are now more numerous than they were earlier in the year.

Closing prices:—

Soft Foreign (Prompt).—Thursday, £20 6s. 3d.; Friday, £20 8s. 9d.; Monday, £20 7s. 6d.; Tuesday, £20 6s. 3d.; Wednesday, £20 7s. 6d.

Institute of British Foundrymen.

London Junior Section.

The London Junior Section held its second Annual General Meeting at the Offices of Messrs. The Industrial Newspapers, Limited, 49, Wellington Street, Strand, W.C.2, on April 27. Mr. P. Ellis (retiring Chairman) presided.

The annual report for the session was read and adopted.

Mr. F. Cummings was unanimously elected Chairman for the coming session, whilst Mr. H. R. E. Slater was appointed Vice-Chairman.

MISS M. D. PITTUCK, in expressing her regret at having to resign from the position, for personal reasons, said she would like to propose that Mr. P. Ellis be asked to take on the secretarial duties of the Junior Section. She had had experience of Mr. Ellis's enthusiasm and energies in the past, when he had helped her several times with her duties as secretary, and she felt that the Junior Section would be very fortunate if Mr. Ellis accepted the appointment.

The motion was carried unanimously, after which Mr. Ellis expressed his willingness to accept the appointment and promised to perform the secretarial duties to the best of his ability.

The following were elected to the Council:—Messrs. F. E. Dodsworth, R. A. Gore, F. Perry, B. B. Kent, V. Warren and Miss M. D. Pittuck.

Votes of thanks were accorded to the Chairman, Mr. Ellis, and his retiring officers for their work during the session, and to the proprietors of THE FOUNDRY TRADE JOURNAL for their kindness in putting their room at the disposal of the Junior Section for its meetings, and particularly to Mr. V. C. Faulkner for his continued interest and encouragement to the members. The motion was passed with acclamation.

"Eyesight" and "Insight."

Following the annual general meeting, a lecture was given by MR. W. H. POOLE, of Keighley Laboratories, Limited, Keighley, entitled, "Eyesight and Insight."

Mr. Poole made his talk very interesting by means of numerous specimens of metal, etc., and a large collection of lantern slides. He explained the causes of different failures which had come under his notice, afterwards describing how each had ultimately been remedied.

A good discussion followed.

After his lecture, Mr. Poole offered a prize, consisting of a complete set of the photographs shown that night, to the Member of the London Junior Section who could write the best résumé of what they had just heard. It was agreed that the Papers must be in before the end of May. A hearty vote of thanks was then passed to Mr. Poole.

Session 1928-9.

The first general meeting will be held on Friday, September 28, but it is hoped that Members will be able to pay a visit to the National Physical Laboratory, at Teddington, on Saturday, September 22.

THE DISTRICT IRON AND STEEL COMPANY, LIMITED, of Smethwick, have entered into an arrangement with the Anglo-Galvanising Company, Limited, of Abbey House, Victoria Street, Westminster, to adopt their process of electro galvanising, and a plant is being erected to meet the demand for galvanising by this process for the trade in the Birmingham area.

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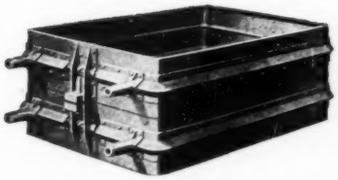

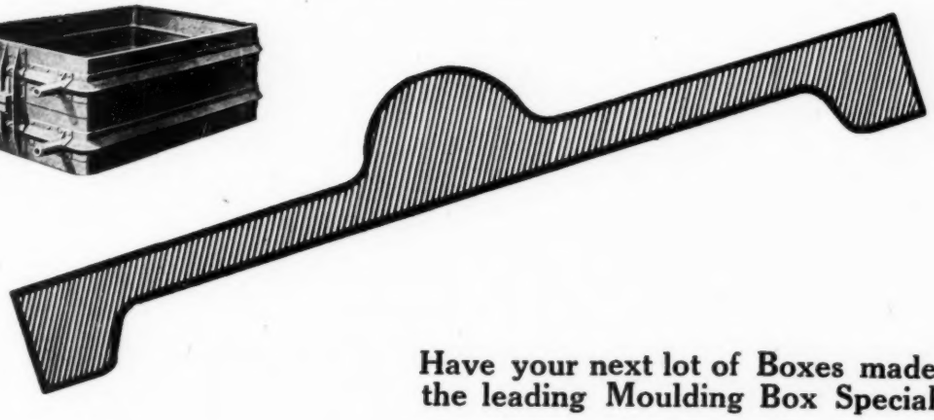

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Best selected ..	..65 0 0
Sheets	..92 0 0
India	..75 0 0
Wire bars	..67 7 6
Do. May ..	..67 7 6
Do. June ..	..67 7 6
Ingot bars	..67 7 6
H.C. Wire rods ..	..72 0 0
Off. av. cash, April ..	..61 14 1 13/20
Do. 3 mths., April ..	..61 16 2 7/20
Do., Sttlmnt., April	..61 14 0 19/20
Do., Electro, April ..	..66 15 0
Do., B.S., April ..	..65 0 0
Aver. spot price, copper, Apr. 61 14 1½	
Do., Wire bars, April	..67 0 0
Solid drawn tubes	13d.
Brazed tubes	13d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g. ..	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares ..	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

	£ s. d.
Standard cash ..	232 0 0
Three months ..	231 7 6
English	236 10 0
Bars	239 10 0
Straits	237 5 0
Australian	233 15 0
Eastern	234 12 6
Banca	Nominal
Off. av. cash, April ..	234 6 0 13/20
Do., 3 mths., April	234 10 7 7/20
Do., Sttlmt., April	234 6 6 19/20
Aver. spot, April ..	234 6 0¾

SPELTER.

Ordinary	..26 5 0
Remelted	..25 5 0
Hard	..20 10 0
Electro 99.9	..30 5 0
English	..26 12 6
India	..21 15 0
Zinc dust	..33 0 0
Zinc ashes	.. 8 0 0
Off. aver., April ..	..25 8 1 7/20
Aver., spot, April ..	..25 9 10½

LEAD.

Soft foreign ppt. ..	..20 7 6
English	..21 15 0
Off. average, April ..	..20 8 8 7/20
Average spot, April ..	..20 6 1½

ZINC SHEETS, &c.

Zinc sheets, English	..33 15 0
Do. V.M. ex whf.	..32 0 0
Rods	..39 0 0
Boiler plates	..29 10 0
Battery plates ..	..31 5 0

ANTIMONY.

Special brands, Eng.	..59 10 0
Chinese	..43 0 0
Crude	..36 0 0

QUICKSILVER.

Quicksilver	..22 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	.. 8 2 6
45/50%	.. 13 2 6
75%	.. 20 10 0
Ferro-vanadium—	
35/40%	..14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	4/6 lb.
Ferro-titanium—	
23/25% carbonless ..	1/2
Ferro-phosphorus, 20/25%	£17 5 0
Ferro-tungsten—	
80/85%, c. fr.	1/3¼ lb.
Tungsten metal powder—	
98/99%	1/7½ lb.
Ferro-chrome—	
2/4% car.	£32 17 6
4/6% car.	£22 10 0
6/8% car.	£22 2 6
8/10% car.	£22 0 0
Ferro-chrome—	
Max. 2% car.	£34 17 6
Max. 1% car	£39 10 0
Max. 0.70% car	£46 7 6
70% carbonless	1/2 lb
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99% ..	..£105 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£13 10 0
76/80% packed	£14 10 0
76/80% export	£13 5 0
Metallic manganese—	
94/96% carbonless ..	1/7 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¾ in.	3d. lb.
Do., under ½ in. × ¼ in. ..	1/-lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length, 10% extra.	

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf ..	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 7 6	
Bundled steel and shrngs. ..	2 19 0 to	3 3 6
Mixed iron and steel	3 0 0	
Heavy cast iron	3 0 0	
Good machinery for foundries	3 5 0	
Cleveland—		
Heavy steel	2 17 0	
Steel turnings	2 8 6	
Cast iron borings ..	2 3 0	
Heavy forge	3 10 0	
Bushelled scrap	3 2 6	
Cast-iron scrap	3 2 0 to	3 6 0
Lancashire—		
Cast-iron scrap	3 5 0	
Hvy. wrought	3 2 6	
Steel turnings	2 2 6	

London—Merchants' buying prices delivered yard.

Copper (clean)	52 0 0
Brass (clean)	38 0 0
Lead (less usual draft) ..	18 0 0
Tea lead	15 10 0
Zinc	15 10 0
New aluminium cuttings..	75 0 0
Braziery copper	47 0 0
Gunmetal	48 0 0
Hollow pewter	165 0 0
Shaped black pewter ..	125 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/6
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas. ..	81/-
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	—
,, No. 4 forge ..	57/6
,, No. 3 fdry.	63/6
Shrops. basic	—
,, Cold blast, ord.* ..	155/-
,, ,, roll iron* ..	—
* d/d Birmingham.	
Northants forge	—
,, fdry. No. 3 ..	58/-
Derbyshire forge	60/-
,, fdry. No. 3 ..	63/6
,, basic	—
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	75/-
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3 ..	68/6
Lincs. forge	65/6
,, fdry. No. 3 ..	66/6
E.C. hematite .. ,,	80/6
W.C. hematite	85/-
Lines. (at furnaces)—	
Forge No. 4	61/-
Foundry No. 3	62/-
Basic	60/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3 ..	71/6
Northants foundry No. 3..	58/-
Dalzell, (ordinary) ..	87/6 to 90/-
Summerlee, No. 3	87/6
Glengarnock, No. 3	87/6
Gartsherrie, No. 3	87/6
Monkland, No. 3	—
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

	£ s. d.	£ s. d.
Iron—		
Bars (cr.) nom.	9 0 0 to	10 10 0
Nut and bolt iron ..		8 7 6
Hoops		11 10 0
Marked bars (Staffs.) f.o.t.		12 0 0
Gas strip		11 10 0
Bolts and nuts, ¾ in. × 4 in.		14 0 0
Steel—		
Ship plates..	8 7 6 to	8 12 6
Boiler plts...		10 10 0
Chequer plts.		10 5 0
Angles		7 17 6
Tees		8 17 6
Joists		7 17 6
Rounds and squares, 3 in. to 5½ in.		7 10 0
Rounds under 3 in. to ¾ in. (Untested)		7 15 0 and upwards
Flats, over 5 in. wide and up		8 7 6
Flats, 5 in. to 1½ in. ..		7 17 6
Rails, heavy	8 2 6 to	8 10 0
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g. ..		9 12 6
Galv. cor. shts., 24g. ..		13 0 0
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	£6 0 0 to	6 10 0
Billets, hard	£7 2 6 to	7 12 6
Sheet bars	£5 16 0 to	5 17 6
Tin bars ..	£5 16 0 to	5 17 6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 8½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila. ..	20.76
No. 2 foundry, Valley	17.25
No. 2 foundry, Birm.	16.00
Basic	18.26
Bessemer	19.26
Malleable	19.01
Grey forge	18.51
Ferro-mang. 80% d/d	100.00
O.-h. rails, h'y at mill ..	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	44.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd., 9 and 10 ..	2.00
Wire nails	2.55
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry ..	—
,, ,, furnace (basis)	12/- to 13/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes ..	20×14	box ..	18/7½	
,, ..	28×20	,, ..	36/6	
,, ..	20×10	,, ..	—	
,, ..	18½×14	,, ..	—	
C.W.	20×14	,, ..	17/-	
,, ...	28×20	,, ..	—	
,, ...	20×10	,, ..	—	
,, ...	18½×14	,, ..	—	
Terneplates ..	28×20	—	per box basis f.o.b.	

SWEDISH IRON.

Bars, hammered, £17 10 0 to	£18 10 0
Rolled Ord. ..£15 0 0 to	£15 10 0
Nail rods .. £15 7 6 to	£15 15 0
Keg. steel nom. ..	..£33 to £35
Faggot steel nom. ..	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron .. £5 15 0 to	

all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas ..	.. 67½% ..	.. 45%
Water ..	.. 63¾% ..	.. 40%
Steam ..	.. 60% ..	.. 35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
May 10 ..	61	13	9	inc.	2/6
,, 11 ..	61	15	0	,,	1/3
,, 14 ..	62	5	0	,,	10/-
,, 15 ..	62	10	0	,,	5/-
,, 16 ..	62	11	3	,,	1/3

Electrolytic Copper.

	£	s.	d.		
May 10 ..	66	10	0	No change	
,, 11 ..	66	10	0	,,	,,
,, 14 ..	66	15	0	inc.	5/-
,, 15 ..	67	0	0	,,	5/-
,, 16 ..	67	0	0	No change	

Standard Tin (cash).

	£	s.	d.		
May 10 ..	234	5	0	inc.	25/-
,, 11 ..	232	7	6	dec.	37/6
,, 14 ..	232	5	0	,,	2/6
,, 15 ..	232	15	0	inc.	10/-
,, 16 ..	232	0	0	dec.	15/-

Tin (English ingots).

	£	s.	d.		
May 10 ..	240	5	0	inc.	25/-
,, 11 ..	237	5	0	dec.	60/-
,, 14 ..	237	5	0	No change	
,, 15 ..	237	10	0	inc.	5/-
,, 16 ..	236	10	0	dec.	20/-

Zinc Sheets (English)

	£	s.	d.		
May 10 ..	33	15	0	No change	
,, 11 ..	33	15	0	,,	,,
,, 14 ..	33	15	0	,,	,,
,, 15 ..	33	15	0	,,	,,
,, 16 ..	33	15	0	,,	,,

Spelter (ordinary).

	£	s.	d.		
May 10 ..	26	5	0	dec.	2/6
,, 11 ..	26	6	3	inc.	1/3
,, 14 ..	26	5	0	dec,	1/3
,, 15 ..	26	6	3	inc.	1/3
,, 16 ..	26	5	0	dec.	1/3

Lead (English).

	£	s.	d.		
May 10 ..	21	15	0	No change	
,, 11 ..	22	0	0	inc.	5/-
,, 14 ..	22	0	0	No change	
,, 15 ..	21	15	0	dec.	5/-
,, 16 ..	21	15	0	No change	

Exports of Iron Castings in April and the four months 1928, compared with April and the four months 1927.

	April, 1927.	April, 1928.	Four months, 1927.	Four months, 1928.	April, 1927.	April, 1928.	Four months, 1927.	Four months, 1928.
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers:—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
To Argentine Republic	166	111	587	546	6,275	4,356	21,392	21,426
,, British South Africa	199	260	901	1,308	7,384	9,273	32,787	45,185
,, ,, India	113	124	427	607	4,451	4,841	18,688	26,730
,, Australia	107	28	398	241	4,627	2,362	20,895	16,998
,, New Zealand	156	170	868	746	8,877	8,627	42,823	36,294
,, Other countries	554	732	2,671	3,074	29,476	32,735	136,929	140,079
Total	1,295	1,425	5,852	6,522	61,090	62,194	273,514	286,712
PIPES AND FITTINGS—CAST—								
To Argentine Republic	1,060	875	3,406	3,066	12,514	9,779	39,790	32,472
,, British South Africa	313	151	1,547	1,431	7,717	3,371	27,668	22,053
,, ,, India	1,048	923	2,203	3,714	15,265	13,224	32,412	45,740
,, Straits Settlements and Malay States	2,200	894	3,608	4,767	18,382	9,254	33,952	44,745
,, Ceylon	146	211	374	457	1,725	2,198	4,956	5,603
,, Australia	345	352	1,277	2,159	4,862	4,301	19,751	24,570
,, Other Countries	5,675	4,710	16,178	20,293	76,507	64,367	236,829	277,801
Total	10,787	8,116	28,593	35,887	136,972	106,494	395,358	452,984
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	363	424	1,599	1,582	13,653	15,529	60,765	58,350
,, Enamelled	76	65	250	274	5,989	5,657	23,803	24,168
CASTINGS, in the rough—								
Iron	44	67	425	379	2,461	3,441	15,465	15,077
Steel	38	62	267	183	1,950	2,796	12,933	8,449

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK
LIMPET

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
19, ST. VINCENT PLACE, GLASGOW.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ADVERTISER, 46, 18 years' foundry and patternshop manager, also foreman patternmaker, grey iron and malleable, desires similar position; knowledge of physical properties; would entertain post as technical representative.—Box 702, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager and Foreman desires position; twenty years' experience in heavy and light loam, dry sand, and green sand castings, Corliss, Uniflow and Diesel engines, surface condensers and machine tools; first-class references.—Box 710, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN wanted, to take charge of Steel Foundry on N.E. Coast; experienced Moulder, with knowledge of modern machine moulding practice and piece-work rates; used to both Converter and Electric Steel.—Apply, stating age and salary required, Box 706, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCY.

LIVE AGENTS required in all districts to handle Core Oils and Creams; good terms offered to suitable men; excellent opportunity for men with Foundry knowledge.—Box 686, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

BUSINESSES FOR SALE

AN opportunity occurs, through death, of acquiring as a going concern a small old-established and profitable Iron Founders' business in North of England.—Apply, Box 700, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

IRON, Brass and Aluminium Foundry Business (2 tons daily) with Buildings, ½ acre Freehold, and Cupola, etc.; adjoining station; £1,500.—GIRLINGS, Maldon, Essex.

MACHINERY.

30-CWT. CUPOLA, 3-ft. 6-in. outside dia.; "Tabor" Rollover Moulding Machine; "Mumford" Squeezing ditto; ton-geared Ladle, 2 ft. 6 in. x 2 ft. 3 in.—Box 698, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOR SALE, Two second-hand Osborne Jar Ram Rollover Moulding Machines.
Two new Tabor Rollover Jar Ram Moulding Machines, and
Two second-hand Grimes Jar Ram Rollover Moulding Machines.
All in absolute perfect condition.
Apply, Box 703, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.—*Continued.*

FOR SALE, M.R.V. Brass Melting Furnaces, No. 45, 440 lbs. capacity, in first-class condition, complete with Keith Blackman Motor-driven Fans.—Apply, DAVID BROWN & SONS (HUDDERSFIELD), LIMITED, Lockwood, Huddersfield.

MACHINERY PLANT, &c., FOR SALE.

New LANDIS 12-in. x 42-in. Plain Grinding Machine.
Rotary Surface Grinder, 16-in. dia. Chuck, with hydraulic movements.
CHURCHILL No. 1 Internal Cylinder Grinder.
LOEWE 22-in. x 13-ft. Plain Grinding Machine.
Three first-class Land-type WATER-TUBE BOILERS, by Babcock & Wilcox, Limited, each with a heating surface of 5,960 square feet, and an approximate evaporation of 22,000 lbs. per hour, with Superheater, Chain Grate Stoker and steam fittings, reinsurable at a working pressure of 210 lbs. per square inch.
"ECONOMIC" BOILER, 14 ft. x 8 ft., reinsure 140 lbs. pressure, by Davey Paxman & Company.
About 7,500-ft. of NEW 2-in. diameter screwed and socketed gas quality Piping, in lengths of about 18/21 ft.
5-ton "GRAFTON" LOCO. STEAM CRANE, 35-ft. jib, 80 lbs. W.P.
5-ton "ISLES" LOCO. STEAM CRANE, 25-ft. jib, 100 lbs. W.P.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

WANTED, 30-ton Tensile Testing Machine, by first-class maker.—Give full particulars, lowest price, and state where may be seen. Box 704, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATENTS AND TRADE MARKS.

INFORMATION HANDBOOKS, Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146A, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

PROPERTY.

11 ACRES WORKS SITE, SHEFFIELD.
145,000 Sq. Ft. of SHOPPING, Compact and Convenient.
SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.
WELL-BUILT & COMMODIOUS OFFICES
Will Sell whole or in lots to suit customers, or Let on favourable terms. Unique opportunity for Manufacturers.
Apply—
THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

PROPERTY.—*Continued.*

WILLIAM MUNSLOW, LIMITED (in Voluntary Liquidation).—TO BE SOLD. FOUNDRY, situate in NEW STREET, MILES PLATTING, MANCHESTER, completely equipped for the manufacture of HIGH-CLASS MACHINERY CASTINGS. The LAND and BUILDINGS are freehold, subject to a YEARLY RENT of £62 11s., and occupy an area of 3,753 square yards or thereabouts. The site is suitable for many purposes, being favourably situated in an important industrial area, with excellent transport facilities, local labour, etc. For further particulars apply to the Liquidator, MR. R. R. SMETHURST (A. Grierson, Son & Smethurst), Chartered Accountant, 21, Spring Gardens, Manchester. (Telephone: City 1814.)

MISCELLANEOUS.

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. BUCHANAN & COMPANY, Ashfield Road, Altrincham, Cheshire.

TERRA FLAKE, Superfine Italian. We have a large consignment to deal with, and offer during May month at one shilling per cwt. below our list's figures. (See our April Catalogue, page 4, Facing Dust.)—WM. OLSEN, LIMITED, Cogan Street, Hull.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

SPRIGS or WIRE PINS?—We supply both. See reduced prices—our April Catalogue, pages 10 and 11.—WM. OLSEN, LIMITED, Cogan Street, Hull.

GLEDHILL-BROOK TIME RECORDERS

FOR ALL KINDS & CONDITIONS OF TIME CHECKING. WRITE FOR ILLUSTRATED CATALOGUE POST FREE.

152 EMPIRE WKS. HUDDERSFIELD.

'Phone: 287 SLOUGH.

TILTING FURNACES

150 lb. M.R.V., Cokefired, NEW	...	£36
250 lb. MORGAN, Cokefired, NEW	...	£50
440 lb. M.R.V., Cokefired, relined	...	£42
600 lb. MORGAN, Cokefired, relined	...	£80
800 lb. MORGAN, Cokefired, relined	...	£90
1000 lb. M.R.V., Cokefired, relined	...	£80

EVERY SIZE LADLE (1 cwt. to 15 ton) in Stock

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH.

GROUND GANISTER
FOR EVERY TYPE OF FURNACE.

STEEL MOULDERS' COMPOSITION.
SUITABLE FOR ALL WEIGHTS AND DESCRIPTIONS OF STEEL CASTINGS.

GEORGE LONGDEN & SON, LIMITED,

Parkwood Road Works, Neepsend, SHEFFIELD.

MANUFACTURERS OF HIGH-CLASS REFRACTORY GOODS.

Telegrams: "Longdenson, Sheffield." **Telephone No. 4577 (2 lines).**